The Internal Context of Bilingual Processing

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Volume 8

The Internal Context of Bilingual Processing
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List of MCF abbreviations

Names	Abbre-viations	Examples/Short descriptions
Affective structure	AfS	!fear! !effort!
Auditory structure	AS	(sound representations; part of POpS)
Conceptual structure	CS	CHEESECAKE, VETO, LOVE, PREPOSITION, LANGUAGE, GOAL, SEEK (the concept of seeking), *SEEK* (a CS primitive)
Core linguistic system	CLS	(the syntactic and phonological modules)
Gustatory structure	GS	(taste representations; part of POpS)
Motor structure	MS	
Olfactory structure	OfS	(smell representations; part of POpS)
Perceptual output structures	POpS	(representations in the perceptual stores)
Phonological structure	PS	(part of the CLS)
Resting level of activation	RLA	(a representation's minimally active state)
Somatosensory structure	SmS	(body representations; part of POpS)
Spatial structure	SpS	(new in the MCF; not part of POpS)
Syntactic structure	SS	(part of the CLS)
Visual structure	VS	(part of POpS)

CHAPTER 1

Introduction

1. Overview

The subject of this book, as the title indicates, is about bilinguals or rather, defined more precisely, about people who use, with varying degrees of ability, more than one language. This definition therefore includes both bilinguals with just two language systems at their disposal and multilinguals. By 'using,' we mean any one of three activities, *understanding* a language, *producing* written, spoken and signed utterances and also using language for *thinking*. We will be focusing on what happens in a bilingual's mind and by extension in the bilingual brain during such activities although mental rather than neurological activity will take pride of place. This means that the notion of 'internal context' should be understood as relating to what happens in the mind rather than events and situations in the world outside, which are located in the external context. This idea of internal context which will dominate the discussion throughout the book will need more explanation, to be provided shortly.

In this chapter, we will introduce the main topic of this book more fully and the direction we intend to take it. As just mentioned, this will mean defining the key notion of internal context and providing a brief overview of the basics of bilingual processing. This will set the stage for the next chapter in which we elaborate the particular theoretical perspective that we will be adopting for the rest of the discussion.

The underlying assumption behind all the chapters that follow is that we cannot properly explain language processing of any kind, that is to say how we represent, store and operate the languages at our disposal, without involving a view of how the mind works *in general*. Accordingly, we need to explain the rationale for our own cross-disciplinary framework, which, though not of course completely free of controversy, we regard as being in line within many contemporary views within cognitive science as a whole. Drawing on research in different areas of cognitive science, we will deal directly with both how bilinguals operate in real time, how bilingual abilities change over time and how processing affects representation, that is to say, the ways in which we make sense of the languages at our disposal as well as write and speak them. Researchers need to be able to avail themselves of sufficiently elaborate, general accounts of mental processing into which to integrate their own, often valuable research findings and produce deeper, richer explanations. We will attempt to show how bilingual abilities can be explained using both the wide range of focused research studies familiar from the literature and an account that puts it into a wider perspective.

2. Internal context

This book is about how context shapes both the way we interpret the world and the way we act on the world. The concept of 'context' has many meanings and has been treated from a great many perspectives in the study of language and beyond. As we indicated earlier, our focus is on the influence of what we have called 'internal' context. In particular, the context we are interested in is the complete mental state of the language user as particular meanings are assembled for processing by the mechanisms responsible for handling the linguistic structures that are needed for production and comprehension. This means that we take the view that there are systems in the mind that are specific to humans and deal exclusively with language and are controlled by principles that determine its morphosyntactic and phonological structure. Then there are other systems involved which, though not specific to the processing of language alone, nevertheless impact in major ways on the course that language processing takes. The way we both interpret and produce speech, sign language and written texts cannot be understood without including all these systems together. Furthermore, by 'language user,' we mean individuals who possess more than one language system with which to accomplish such tasks, whether they are literally bilinguals or whether they are multilinguals who know more than two languages (Cook, 2002).

In sum, we seek to understand how the person's use of the two or more languages is shaped by what else is going on in his/her cognitive system (mind) at the time. This activity – what is going on – constitutes both the workings of language-specific systems and our particular area in focus, the internal context. Characterizing the activity is of great interest not only in itself but also as a source of insights about the mind in general.

2.1 Bilingual processing

We shall naturally have a great deal to say about many aspects of bilingual processing with reference to our notion of internal context during the course of the book. Further background information about bilingual processing in general is available from introductory texts and handbooks already published (see for example Bhatia & Ritchie, 2013; Bullock & Toribio, 2009; de Groot & Starreveld, 2015; Kroll &

de Groot, 2005; Pavlenko, 2009c; Schwieter 2015). Nevertheless, it is important here to briefly go over some of the basic concepts and issues which are important generally in discussions of bilingual processing but are especially important for understanding what we mean by internal context.

All accounts of cognitive processing will have at their heart the notion of *activation*. In those accounts, which, like the present one, assume some sort of symbolic representational system, representations exist as nodes in a network, or network of smaller networks: this defines the manner in which they each do or do not relate to one another. In this way individual linguistic representations may be *co-activated* with other representations that they are associated with (the topic of Chapter 9). A very simple example would be a noun phrase network with a head noun, two adjectives and a determiner as in 'the large red apple', for instance, or a lexical semantic network which might include apple, orange, cherry, banana, etc. Activation is not an on-off affair but a matter of degree. In other words, representations including smaller and wider representational networks can be *more or less active* at any given moment.

In the most reductionist accounts that we will not be dealing with, the focus is on the networks that are activated and the nodes in the network are less important in themselves and may be completely contentless and not even labelled. In the case of representational networks however, it becomes important to define the various types of representation and the tighter or looser ways in which they may combine to form co-activating networks. These larger networks thus become complex representations in their own right, like a noun phrase as opposed to any one of its component parts or a whole sentence.

When it comes to language, the number of options for combining syntactic forms with various meanings (conceptual or semantic representations) is already extremely large but it increases even further when the network expands to include more than one language. Since under normal circumstances we cannot coherently speak or understand two languages simultaneously, we have to make choices as two systems provide possible solutions to getting meaning across to someone else or interpreting the meaning of language addressed to us. Language processing accounts have to explain how conflicts between various options are resolved (or not).

One major insight that has emerged from contemporary work on bilingual processing and which will be discussed in more detail later is the fact that *all* language systems in the possession of a bilingual are activated whatever the language currently being used. In other words, it appears that, although one language will be currently dominant, it is not possible for bilinguals to totally disable, i.e. to 'switch off' the other supposedly irrelevant language(s) they know. One language is activated alongside the others and, since as we have indicated, activation is a matter of degree, this means continual *competition*. Accordingly, all accounts of bilingual processing have to explain how this happens, what the crosslinguistic effects are and the extent to which competition between language systems can be kept under control to prevent the disruption of communication. These effects will often be unintended and subconscious but a comprehensive account must also explain deliberate switches between languages, i.e. so-called code-switching (see the final section of Chapter 9).

Traditionally, language processing research has concentrated on processes that can be tracked millisecond-by-millisecond. In other words the focus has been not on the nature of representations, in our case including linguistic representations and their properties. Rather it has been on *online processing* performance leaving the question of representations, for those approaches where representation is a crucial concept, to fields such as theoretical linguistics to deal with. As will be clear from what follows, processing and representation in this book will be treated as necessary parts of the same story: explanations of bilingual processing, in fact any type of cognitive processing must include both.

Another area which will also be incorporated into the account is how bilingual systems change over time, that is how they are acquired in the first place and how they undergo changes which are usually referred to under the rubric of *language attrition*. Here crosslinguistic effects are also important as one language system influences the other over time. This may affect a bilingual's original first language, if they were born monolingual, or any other language that has ceased to be dominant and fallen into disuse.

Finally, because the approach to be adopted in this book takes not only language cognition but all of cognition into account, it has important things to say about bilinguals' *metalinguistic abilities* and their conscious control of their language activity. This involves abilities that are not specifically to do with language alone. 'Control' is a notion that can be related to claims in the literature about the possible advantages of bilingualism for the mind in general. The challenges that bilinguals are faced with, dealing with the competition between systems that can disrupt or slow down performance and the possible limitations they may face under certain circumstances, may be outweighed by some significant advantages in cognitive capacity stretching into old age. Note that control is something that does not necessarily entail conscious awareness: it also operates beyond conscious control. It is also very important to understand how the various subsystems interact, often in the absence of awareness. This constitutes a major challenge for cognitive science to unravel and as such merits serious discussion in this book with regard to bilingualism (see Chapters 6, 7, and 8 in particular).

2.2 The interpreted world

The first step in making sense of context is to make a fundamental distinction between the world outside and the interpreted world that provides the basis for the internal context for any act of language interpretation. 'Inner' and 'internal' mean 'in the mind'. Much has been written about the external context, the main focus of sociolinguistic research, but here, when talking about context, we are much more concerned with the way that states and events in the outside world are interpreted by individual minds. In his *Aspects of the theory of syntax*, Chomsky (1965, p. 58) referred to a human or animal's 'theory of the external world' and this idea has long engaged philosophers, Locke and Hume being obvious examples. Obviously not everything present in the external world will have an effect on language performance but explaining what features 'out there' we do somehow incorporate into our internal world is a more complicated story. Certainly, as we respond to what is around us, we have the powerful illusion that our response is indeed literally and directly to what we assume to be outside us and not anything within us. In point of fact, these responses are to the world that we have reconstructed within: This is partly from the immediate sense impressions we have been getting but the recreation process is strongly influenced by what is already inside, our assumptions and biases that previous experience has created plus the biological limitations imposed by our human sensory capacities. This means that, for us, the real world is actually the inner recreated one which will have a unique character for every individual (see Figure 1.1).

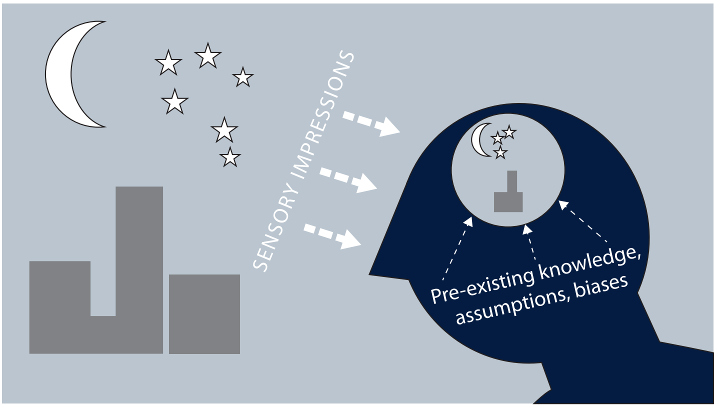

Figure 1.1 The external and interpreted worlds

The notion of context being somehow created internally, i.e. in the mind, is certainly not new in modern linguistics. It surfaces in a number of theoretical perspectives and is often used with respect to something which is created during an act of processing. In Relevance Theory, for example, 'cognitive context' is constructed to establish relevance, and context in this sense is a psychological construct which as Sperber and Wilson (1995) put it 'is not limited to information about the immediate physical environment or the immediately preceding utterances: Expectations about the future, scientific hypotheses or religious beliefs, anecdotal memories, general cultural assumptions, beliefs about the mental state of the speaker, may all play a role in interpretation' (pp. 15–16). Another example would be Teun van Dijk's approach which sees individuals as forming cognitive models of both the contexts they are in and the events that occur (van Dijk, 2001). We will return to this topic in Chapter 3.

Internal context is thus about how we interpret the world outside. But it is also about how we act upon the world. All of our actions, including our uses of language, are based on internal representations of the immediate situation in which we find ourselves, against the background of stored experiences from the past. These representations are what might be called the 'outside-in context' as they are our inner representations of the current external context. The context of (bilingual) language processing provides an example of these two types of context, the outer one and the recreated inner one. The things that we say (write, sign) are based on our perceptions of where we are, who we are talking to, what has been said so far, and so on. Again, the inner world of interpreted experience shapes our actions and thus forms part of the internal context of processing.

2.3 The meaning of 'context'

The way the term 'context' is used here may need some further elucidation as, in linguistics at least, context is so frequently associated with the world outside the individual whether it be the social or environmental context as a whole or the immediate situational context while language processing is taking place.

As will have been made clear already, there is, in this book, such a thing as 'context' that is not located in the external world. We would explain this use of context in the following way. The cognitive system as a whole is viewed as a space in which there is one area specifically devoted to linguistic structure, i.e. creating, storing and processing it online. We make a distinction between 'linguistic' and 'language'. The special linguistic area that occupies part of the total space, i.e. the mind, is conceived of as a special domain. The main point being made here is the fact that how we produce and interpret meanings using this particular domain only takes us some of the way towards *effective, comprehensive language processing*. In other words, the domain occupied by the systems that deal with *linguistic structure* should not be thought of as solely responsible for the complete processing of *language*: to do this, the whole cognitive system must be involved. Internal

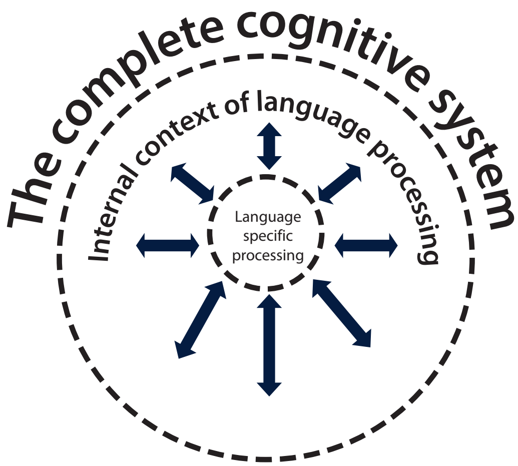

Figure 1.2 Internal context

context, the focus of this book, is, then, the complete mental space surrounding and interacting with the language-specific or 'linguistic' domain just mentioned (see Figure 1.2) and involves a number of other systems to be described in the final section. Together the inner and outer areas are where *language* processing takes place. This means that the whole mind is involved in language processing and not just the dedicated linguistic domain represented in the figure by the inner circle. As will be seen shortly, two major systems occupying the surrounding space (the internal context space) are the *conceptual* system where all abstract meaning is dealt with and the *affective* system which deals with emotion and values. These are not represented in the figure but will play a major part in the following discussions.

2.4 Two types of internal context

Elements other than those that constitute the outside-in context are no less important, goals being the clearest example. Whether the goal is to become rich and famous, to get to work on time, or to reach for a glass of water, goals guide most, if not all, of our thought and behavior (see Carver & Scheier, 1998, and the discussion in Chapter 4 and references cited there; relevant findings and discussion can also be found in Baars, Fehling, LaPolla, & McGovern, 1997; Ferguson, 2008; Gollwitzer, 1983; Marien, Custers, Hassin, & Aarts, 2012). The goals that we hold are thus a crucial part of the internal context of processing. Also prominent are emotions and the value judgments that go with them: We seek things that we value and avoid things that we fear or hate or simply find distasteful (Damasio, 2010; Edelman, 1992, 2006a, 2006b; Ekman, 2003; Montague, 2006; Panksepp, 2005). Perhaps the ultimate inner influence on our actions is the self (Baars, 1988;

Baumeister & Tierney, 2011; Damasio, 2010; Dörnyei, 2009; and see the discussion in Chapter 4). While the concept is controversial and is certainly confused, it is difficult to deny that something real lies behind it and that this something is important for understanding how we deal with the world. It is, in other words, part of the internal context.

To distinguish the second set of contextual elements from sensory-based representations of the outside world, we will refer to goals, emotion, value, and self jointly as *inherently internal context*: This means simply that they are internal contextual elements that are not representations of the outside world. This distinction will prove very useful in the explication of internal context throughout this book and they will all be discussed in greater detail later.

The two types of internal context, the immediate, outside-in one and the inherently internal one, have much in common and are in practice intertwined. While goals are not representations of the world, to a large extent they are, like outside-in context, established in response to the sensory-based interpretations that make up outside-in context. Self is constructed, possibly from a pre-existing base, through experience with the world and, like goals, it shapes outside-in context. Some emotions are almost certainly inherent in the system, but even these most basic emotions act as context only to the extent that they are associated with other representations, notably those established through sensory experience. Value is the most clearly inherent of all these elements, but its contextual effects are also a product of associations with other representations, formed largely through experience with the world.

We should stress that activation is required for these elements, outside-in and inherently internal ones, to constitute internal context. They become internal context specifically *when they are currently active in the system*, and *to the extent that they are currently active*. Representations of a particular person become (outside-in) internal context when they are activated by perception of that person or by thoughts related to that person. A particular goal serves as (inherently) internal context only after it has been activated and therefore can influence current processing. In any given instance of processing the vast majority of the items that could potentially serve as context are not active and so do not qualify as internal context.

Finally, a limitation on this dichotomy should be noted: Like most dichotomies, it is not entirely exhaustive. We can imagine elements of the internal world that, when active, influence processing but without fitting neatly into either category. Our claim is that the distinction covers the great bulk of what needs to be considered and provides a useful way to approach the questions of how processing is shaped by internal context. This applies particularly to issues of bilingual processing and its internal context.

3. Context and cognition

Understanding the processes that determine how language is used must be based on an understanding of how language functions within the mind as a whole. The theoretical framework within which most of the discussion will take place is one that handles both monolingual and multilingual processing but using precisely the same architecture. Furthermore, in case it is not clear already, our use of 'language' is a broad, comprehensive one. This means for us that it includes both mental systems that deal exclusively with linguistic structure, namely syntax and phonology, and many other systems such as the motor system and the affective system, the primary function of which is typically not linguistic. The conceptual system, dealing with all kinds of abstract meaning is also not a specifically linguistic one although language-related concepts do represent a large chunk of its repertoire of representations.

3.1 Deconstructing 'input'

With respect to the two complementary perspectives on context, namely the sociological 'outside' view and the psychological 'inside' view, one useful way of highlighting the differences between them is to consider what developmental linguists, especially in second language acquisition research, have long called 'input'. This has to do with an individual's exposure to the language in question. Input is most often used as a metaphor for the language a given individual is exposed to, the language events going on outside. Corder (1967) coined the term 'intake' to distinguish what language is external to the individual and potentially processible by them (input) and that portion of it that has actually been processed, 'taken in' and resulted in learning.

This concept of input as commonly used in the literature promotes a simplistic view of what actually happens (Carroll, 1999, 2001; Sharwood Smith & Truscott, 2014a, 2014b). There are two reasons for this. The first reason is that it suggests that language is somehow 'put in' from outside whereas in fact what really happens is that particular kinds of physical activity happening around and outside us, sound and light waves for example, may impact on our senses and what is initially processed is in fact raw perceptual data: For the individual concerned this data is devoid of any information at that particular point in the interpretation process and informational content has been reconstructed or, more precisely, created at subsequent processing stages. For this reason, Carroll (1999) proposed that the term 'input' in its standard sense should be discarded and 'sensory data' should be used instead.

The second reason why 'input' is an unhelpful term in language acquisition research is that its interpretation is normally used to refer exclusively to *linguistic* input; 'linguistic' refers here to just those sensory data that carry evidence of the phonetic, phonological and morphosyntactic forms being used, in other words sensory data that can be interpreted, at some later stage, as reflecting particular linguistic structures. This would involve only what would still be a subset of the totality of sensory data at any given moment: It would exclude other sensory data that provide contextual information relevant for the full interpretation of whatever message is being conveyed (Sharwood Smith, 1986). Excluded are sights, including pointing and gesturing, sounds, smells, tastes etc., in other words everything that contributes to the interpretation of an utterance and which can lead to further development of an individual's linguistic ability, i.e. all the relevant external context. This should be included in a comprehensive understanding of what input is.

3.2 Deconstructing 'output'

The subtleties and complexities concealed in the idea of input are matched by those of the parallel concept of output. In SLA this is a prominent notion, but what exactly it means has never been entirely clear. As with input, there are the readily observable sounds and written forms. But, as with input, we cannot understand the concept without going well beyond the observable. This means, first of all, exploring the language system that produced the output, as is commonly done in bilingualism and SLA. But, again as with input, output is much more than just its linguistic aspects, i.e. its sounds, its core meaning, and the formal structures embedded in it. It is produced in the context of the cognitive system as a whole and inevitably embodies various features of that context. In particular, we can identify the speaker's goals, the associated emotions, and the value attached by the speaker to the utterance and its various components. Even beyond these crucial elements, we can say that output is an expression of the self, that whenever a person says anything, it reflects to some extent the distinctive character of that person. Neglecting these elements means accepting a superficial understanding of 'output'.

3.3 Input, output, and internal context

The cognitive system is made for interpreting the world based on our nature and our needs, and for acting on this interpreted world based again on our nature and needs. Every instance of processing takes place in the context of this system and its current activity – and is shaped by this context. This certainly applies to bilingual processing – its character is based to a very large extent on the internal context in which it occurs.

Internal context in this sense is everything present in the cognitive system of the individual in the form of currently activated representations and their on-line interactions with one another. This is the basis on which an individual interprets and produces utterances in a given language. As noted earlier, the contextual information that is created internally on exposure to sensory data at a given moment in time necessarily interacts with the *already existing* interpreted world of an individual, and both owe a great deal to the innate character of the system. It should also be stressed that the internal world consists not simply of knowledge or beliefs but also of our goals, our emotions, our values, and our selves, all of which constitute crucial elements of the internal context of processing, parts that we refer to as inherently internal in order to contrast them with representations of the current outside situation.

Making sense of all this is a challenging task and is only really possible with a reasonably elaborated and coherent theoretical framework, one that can simultaneously handle the very different aspects of cognition implicated in bilingual processing. The following chapters will not only deal with strictly linguistic issues but have much to say about fundamental psychological concepts that explain goals and goal-directed behavior, the way in which self, value and emotion influence processing as well as topics that have been particularly prominent in the psycholinguistic and neurolinguistic literature in recent times, notably including working memory and executive function otherwise referred to as cognitive control. Before moving to discuss these issues, it is first necessary to set out the theoretical stance we will be taking. This will be further elaborated in the second chapter.

4. Models of the mind

4.1 Modelling bilingual processing

The book offers a broad theoretical discussion of bilingual processing. More specifically, the ensuing discussion will contribute to building up a coherent picture of the bilingual's internal world and the way it shapes internal context. It will then go on to show how some central concepts in cognitive science and bilingualism fit in with – and follow from – the proposed view of internal context. These concepts include, among others, working memory, consciousness, executive control, attention, effort, codeswitching, and the possible cognitive benefits of being bilingual. As just suggested, an investigation of this complexity requires a broad framework offering a relatively clear account of the cognitive system and the place of language in it. The framework to be used will accordingly be introduced separately in Chapter 2. In a later chapter, we will look at some frequently discussed models in the bilingualism processing literature, for example the Revised Hierarchical Model (RHM), the Bilingual Interactive Activation Plus Model (BIA+), Bilingual Language Interaction Network for Comprehension of Speech (BLINCS) and the inhibitory control (IC) model in order to see how they can be related to our broader framework (Dijkstra & van Heuven, 1998, 2002; Green 1986, 1998; Kroll & Stewart, 1994; Shook & Marian, 2013). However, even before outlining the architecture of our own, overarching framework, there are some important characteristics of the mind to consider first. These are key characteristics that any overarching framework, in our opinion, should reflect. The first has to do with who or what is 'in control' of processing. The second has to do with the extent to which we can regard the mind as a stable system or one that is constantly in flux.

4.2 The heterarchical mind

It would be easy but naïve to imagine that the mind operates in a linear hierarchical fashion with a single coordinating center, perhaps involving consciousness or perhaps some subconscious homunculus. In fact, language comprehension is not a steady unidirectional flow from sensory data to conscious message interpretation, in other words 100% bottom-up. In a similar manner, language production is not a steady top-down sequence of operations beginning with conscious message formulation and ending with the articulated message in speech, writing or sign language. Most would now accept that a vast amount of mental processing operates below the level of consciousness and, in many cases, in ways that are completely inaccessible to conscious awareness, and therefore not under conscious control. Both language comprehension and language production are a combination of top-down and bottom-up processing: The direction of travel shifts back and forth and is largely below the level of conscious awareness. The ultimate outcomes of both modes of language processing are reached after an incremental process achieved by different subsystems that can operate in parallel.

This suggests that the mind is best characterized as 'heterarchical' (McCulloch, 1945, p. 89; see also Bruni & Giorgi, 2015; de Mey, 1977; McCulloch, 1988; Sharwood Smith & Truscott 2014b, p. 21). It has a set of interconnected systems that can, to a certain extent, operate independently. They may well each contain various fixed hierarchical processes but overall the chain of command can shift as task priorities change so that there is no single path and no fixed direction in which operations are carried out. As will become clear later, in discussion of conscious processes and the concept of self, there is a necessary qualification to be made about the mind being completely heterarchical. However, as a general principle, it provides an adequate characterization of the ways in which cognitive processing works in general.

4.3 The mind: A dynamic or a stable system?

The idea of a flexible, heterarchical mind fits in easily with the idea of a mind that, like the brain, is constantly active as the various subsystems interact in response to different task demands both in waking and in sleeping. With the enormous variety of tasks that the mind is faced with and the different combinations of subsystems that must be recruited to deal with them in a constantly changing environment it would be foolish to promote an idea of the mind as a fixed processing system comparable to a simple computer. Dynamical systems theory as applied within cognitive science is based on this idea as are other emergentist approaches (see, for example Behrens, 2009; Smith & Thelen 2003).

Nevertheless, despite the apparent chaos and changeability it is faced with, the mind does handle the outside world in often predictable ways and, when working out a plausible architecture to describe and explain it, there is clearly a need for identifying what is stable and fixed. For generative linguists, one classic example of this is setting the enormous variety that the world's natural languages display against the identifiable limits imposed on the possible shapes which not 'languages' but grammars can take (Chomsky, 2000; Lightfoot, 1982; Yang, Crain, Berwick, & Bolhuis, 2017). Another example from biology would be the great variety of shapes into which snail shells can grow in contrast to the relatively small number of fixed mechanisms that can explain this variety (Goodfriend, 1986; Kuroda, 2014). In other words, stability and dynamism need not be regarded as incompatible when explaining variety and complexity in a system. Systems each with fixed ways of operating when interacting with other systems and/or with events in the outside world will produce variable and dynamic behavior (see Sharwood Smith, 2019a).

4.4 The drive for coherence

Few would disagree that the mind is a dynamic system at least in one form or other. It should also be clear that there is no mysterious subconscious homunculus supervising the mind on our behalf. Rather, the mind must be responding in some other way to ever changing situations by means of continually shifting patterns of control appropriate to the task in hand. We will be dealing with this more extensively in later chapters when discussing control.

Coherence is particularly important when discussing context since as more and more language is processed, what has already been processed has to be integrated with new information. Put another way, an important part of trying to make sense of new input is finding a best-fit between the new and what is already known. This includes aligning new information with already established background knowledge as well as with what has just been processed. With no supervisory subconscious homunculus but only continually shifting patterns of control in response to ever changing situations, potential chaos could result. In actual fact, a counterweight to its dynamic and unordered nature consists in its drive for equilibrium and coherence.

4.5 The status of consciousness

In tune with most current thinking in cognitive science, conscious mental activity although extremely important in all kinds of ways still represents a very small part of mental processing, most of which goes on below the level of awareness and often *cannot* involve consciousness (Truscott, 2015a, 2015b). As will be explained in detail later, the system that plays a crucial role in creating the internal context is the one which is responsible for processing and storing abstract meaning, the human conceptual system, and this system plays an important indirect role in conscious experience. By 'conceptual' we mean what psychologists usually refer to as 'semantic' although this covers more than the standard linguistic meaning. For linguists we stress that conceptual also covers other than just basic meanings, in other words pragmatic and discourse meaning as well, in fact everything to do with any kind of meaning (see Chapter 3).

One of the characteristics of the conceptual system as used in this book is that, subject to certain conditions – basically the intense activation of conceptual representations involved – some of its contents can be projected into our perceptual systems. This provides the major contribution to our experience of conscious thinking and it will be explained in more detail in subsequent chapters. This function that the conceptual system has opens up many possibilities for conscious responses to what we perceive are relevant contextual features in the environment for the interpretation of whatever language we are currently processing. For bilinguals who are sufficiently bicultural as well,[1] inevitably the same contextual features will trigger alternative interpretations. The conflict created by any resulting ambiguities can in principle be resolved by conscious introspection. For example, if a speaker is behaving in a friendly manner while at the same time saying things that, in the different linguistic and cultural context of a listener would be interpreted as insulting, the conflict could be resolved by working out from the speaker's own conscious knowledge of the two cultures, the speaker's and the listener's, which is the more likely interpretation. This will allow the initially preferred interpretation

1. In principle it is possible to be totally immersed in one culture only while speaking two languages both of which are used with exactly the same cultural associations. Swedish-speaking and Finnish-speaking Finns are sometimes cited as examples of bilinguals who have one culture and two languages but in reality 'biculturalism', like bilingualism, has to be a relative matter.

associated with the listener's dominant language to be reversed in favor of the correct interpretation. This often fails to completely remove the feeling of having been insulted but it will give the individual control over their response. Without the possibility of conscious introspection, this reversal of interpretations would never take place.

5. Theoretical frameworks

To sum up so far, internal context in this book will cover not just the particular internal context being created during a specific act of processing but an individual's current interpreted world as a whole and how that contributes to language, and particularly bilingual processing. This enterprise requires a broader frame of reference, some reasonably coherent idea of how the mind might work to create and use internal context. This broader frame of reference will be the topic of the second chapter but some preliminary remarks will be made below. It should become increasingly clear in the course of this book that, from a psychological perspective, while it is still perfectly possible to make distinctions between narrowly linguistic context, situational context and the broader sociocultural context, the mind in any given situation will be combining all the types of context in order to make sense of a given utterance or to make an utterance that makes sense.

5.1 Broad and narrow explanatory frameworks

For the coherent analysis and explanation of any psychological phenomena, it is important to have an overall explanatory framework. If one looks at the existing research literature with this in mind, two things become clear. Firstly, the set of assumptions that go along with any discussion are not always mentioned. This is presumably because authors either take certain assumptions for granted or they believe that the theoretical assumptions they are making will be clear from the context. For example, an article dealing with some aspect of syntax using a generative linguistic model will feel no need to spell out in detail all the principles on which the model is based because the readers will take them for granted as well.

Sometimes riskier assumptions seem to be made when a common concept is used as though its nature is generally understood when in fact the opposite is the case: There happens to be no agreement as to what exactly it entails. For example, there may be reference to something like 'executive function' in the psychological literature when, if put on the spot, the only acceptable definition will be vague because this concept has not yet been fully explored enough for anyone yet to form a plausible and detailed account of what exactly it is (see, in particular, the discussion of control in Chapter 6). In such cases, where the speaker may be perfectly aware of the problem or else blithely unaware, there is a silent 'whatever that is' to be added after the term is mentioned. Another possibility is that there are many accounts around but the writer has not explicitly stated which one in particular should be assumed for the current discussion.

The second thing that should become apparent when examining the research literature is that when there is an explanatory framework, whether explicitly stated or implied, within which the current discussion is taking place, it is typically a framework that we would call domain-specific or 'narrow (see fuller discussion in Truscott & Sharwood Smith, in press). In other words, it is based on an important hypothesis or theory which has been proposed to explain only phenomena appropriate to a given field of research.

5.2 The Modular Cognition Framework

The theoretical framework to be used in this book, the *Modular Cognition Framework* (MCF) is, as its name indicates, a framework that covers all of cognition and not just language: In other words, it definitely falls into the 'broad' category. As an overarching framework it does not replace smaller ones but places them in a broader explanatory context albeit with one proviso: Narrower frameworks must be compatible with the main principles of the selected overarching one. This still allows for many alternative explanations for selected phenomena covered by the wider framework. There are other wider perspectives available which have been applied to language. One example is the dynamical systems and related emergentist approaches referred to above (see also Hernandez et al., 2019; O'Grady 2005; Onnis & Spivey, 2012; for comparisons of other broad approaches with the MCF, see Sharwood Smith, 2019a; Sharwood Smith, Truscott, & Hawkins, 2013; Truscott & Sharwood Smith, in press). The MCF shares some basic characteristics with these approaches (see also proposals in Christiansen & Chater, 2016; Vigliocco, Perniss, & Vinson, 2014) but crucially differs in one important respect in that it is a *modular* approach that (broadly) follows the language and general cognitive architecture proposed by Jackendoff (1987, 2002), including domain-specific modules devoted to linguistic processing. However, in that it assumes symbolic representations and is a computational account, it is not a connectionist approach, at least in the classic sense of connectionism as set out in McClelland (1981) and this despite the fact that it uses many concepts associated with connectionism such as network, spreading activation and parallel processing as well as an expressed desire to relate cognitive processes with neural architecture.

Up till recently the MCF has been referred to as the Modular Online Growth and Use of Language (MOGUL) framework (Sharwood Smith, 2017b; Sharwood

Smith & Truscott, 2014b; Truscott, 2015a; Truscott & Sharwood Smith, in press). MOGUL, which has been undergoing continuous development since 2000, reflects the focus of all related publications to date and our primary concern, namely *language* cognition. However, the underlying assumption of MOGUL has always been that explanations of any linguistic phenomena – and this naturally includes those phenomena pertaining to bilingual processing, the topic of this book – cannot be fully explained without a proper account of how they fit into human cognition as a whole. Whereas language does connect up with all other parts of the mind, mental activity covers much more than language processing and storage. In this way, the MOGUL acronym reflects our preoccupation with language and is best thought of as a project in which the MCF is applied to this area of cognition, the latter term (MCF) more faithfully reflecting the broader 'mind-wide' perspective.

5.3 Language in the mind

One thing that the MCF provides is a crossdisciplinary working model of the mind. 'Working' here is used in the same sense as in the phrase 'working hypothesis', i.e. it may be thought of as a currently plausible theory of the mind's basic architecture. To establish a reasonable level of plausibility, the model is based on compatible research theories and findings in relevant areas of cognitive science: This includes the various branches of linguistics, psychology and neuroscience. It has always been work-in-progress, the general idea being that advances in any one of these areas should be regarded as challenges and potential contributions to further development. By the same token, the way in which the model is able to accumulate detail and add precision to the description of mental functioning should feed back into the source disciplines. In other words, the potential contributions should flow in two directions.

The need for such a model from a more purely linguistic perspective should be clear. Language cognition cannot be treated in isolation from the mind as a whole. The way we represent language can be studied this way but ultimately this cannot be the final stage in the process of explanation. Again, in looking for explanations concerning any aspect of language processing, restricting the explanation permanently to only those aspects which are clearly and specifically linguistic in character imposes severe limitations. It is almost always the case in practice that references are made to more general concepts such as, for instance, 'working memory', 'executive function(s)' and 'declarative knowledge' relying on one particular interpretation of what they mean and how they work. There is a serious risk of relying on outdated ideas if these crucial concepts, which are by no means free of controversy, are imported unquestioningly for the purpose of explaining linguistic phenomena without properly considering their status and function in the mind as a whole and without taking seriously current debates and alternative perspectives on how exactly these general concepts should be understood.

5.4 Distinct levels of description

Although the MCF draws on research in various related disciplines, it should be stressed that it is about the *mind*. It is not about the physical *brain*. Put another way, it is about psychological functioning. At the same time and as mentioned above, we regard it as very important to keep a watchful eye on developments in neuroscientific research since we are assuming that mind and brain are closely related even though many relationships are not likely to be simple one-to-one associations between a given mental function and a neural one. All psychological functions are nevertheless understood to have neural correlates and so it pays to keep in touch with brain research as much as possible and facilitate rather than frustrate the establishing of links between the two. Our psychological account of motivation and emotion, for example, should surely benefit from neuroscientific debates on affective states (e.g. LeDoux, 1996; Panksepp, 2005). In sum, the psychological level and the neural level should be kept distinct but also kept related as clearly as possible. It is important to have these relationships stated explicitly in order to avoid confused thinking as when, for example, *cognitive* reserve in research on aging in bilinguals is confused with *brain* reserve (see discussion in Abutalebi et al., 2015).

Respect for the different levels of description should encourage crossdisciplinary collaboration (for further discussion see Sharwood Smith, 2017b, pp. 5–8). Exactly the same holds within a large research domain such as linguistics. Take, for example, the theoretical linguistic level where no claims are made about language processing and, on the other hand, the psychological or 'psycholinguistic' level which is devoted to such claims. Theoretical linguistic descriptions of the way language or languages are structured are generally made in the abstract free of time and space considerations. For this reason, linguists working at this level of abstraction are able to freely employ time and space metaphors to describe and explain linguistic structure. Their models will provide ways in which different elements of linguistic structure relate to one another and these may be presented as principled interactions. 'Interaction' is a safe real time metaphor in this context but only the psycholinguistic level deals directly with processing in real time. This means that the interaction between linguistic structures conceived as abstract representations needs to be reconsidered when accounting for real time interaction. Put another way, how should we describe the psycholinguistic equivalents of abstractly conceived linguistic representations like noun, noun phrase, complement, etc.? Again, still keeping the levels relatable in principle is worthwhile for much the same reason as stated above for the more fundamental neural and psychological levels.

Theoretical linguistic level	Psycholinguistic level	Neurolinguistic level
– Representations of linguistic structure divorced from time and space	– Psychological representations and processes divorced from space but not time	– Neurological representations and processes involving both spatial and temporal dimensions

Figure 1.3 Three levels of description

5.5 The role of overarching and 'local' theoretical frameworks

Since misunderstandings can easily arise about what to expect and what not to expect from a crossdisciplinary theoretical framework, something needs to be said at the outset about the principal functions of any kind of theoretical framework, one of which is *interpretation*. It also functions as a *guide*: In this sense it can help shape theories and hypotheses in one or other of the disciplines which it is related to. Hypotheses in a given area of investigation arouse different expectations. They may or may not be derived from theories but they are routinely recast as predictions in experimental research. The two concepts are not the same and should arguably be kept separate. A hypothesis is a potential explanation. A prediction is simply saying something will happen for whatever reason. Where predictions are linked with specific hypotheses, empirical research can yield data which is supposed to support or fail to support the hypothesis in question. If the unsupported hypothesis happens to be linked with a body of interrelated hypotheses making up a theory then the theory may have to be adjusted if not called into question. The predictions, the hypotheses and the theory are usually 'local' in that they cover ground within a particular research field. As will hopefully have already become clear, the kind of framework used in this book is not a local framework but crosses disciplines and thereby lends a further dimension to any local explanations of data which may have important implications reaching beyond the bounds of the current field in question. For this reason, we regard the use of wider frameworks as a necessity rather than a luxury extra.

As mentioned earlier, it is possible and indeed common to have narrow (local) theoretical frameworks, such as the *Minimalist Program* in theoretical linguistics for example. Local frameworks also have a guiding and interpretative function but this time restricted mostly to the relevant research field even though they may often have assumptions or claims that extend beyond the domain which they are designed to explain. Again, because they are theoretical frameworks rather than fixed theories, they set out basic principles which serve to give direction to more precisely defined lines of enquiry. These allow for different directions to be taken within the confines of basic principles: Alternative accounts for target phenomena may therefore be debated provided they are all compatible with the overarching framework (see also discussion in Truscott & Sharwood Smith, in press).

It is perfectly possible and quite common indeed for research to be carried out without an overarching theoretical framework of either kind. Some work with or without a specific, precisely defined theory in mind and others just proceed only with careful small-scale hypotheses and predictions hoping that a broader theoretical explanation will emerge as findings accumulate and point in one particular direction. There may be some general background assumptions, for example those provided by various emergentist approaches to cognition, and these do help guide such research, but they will not be organized into a framework as such. The fact of the matter is that many researchers routinely make background assumptions without explicitly stating them or considering them, or maybe even recognizing them.

An explicit framework is the solution for this problem so that investigators in any relevant field of research can, using a chosen framework, explicitly position themselves with regard to all the key concepts that these implicit background assumptions entail. This also holds for the kind of broad-based explanatory framework promoted in this book. Many targeted, i.e. domain-specific theoretical models, when they do venture outside their chosen domain stray only as far as it serves their immediate interests. A more comprehensive approach modelling all cognitive processing should help to fill the many explanatory gaps left by such a strategy.

5.6 On defining representations, structures and memories

Finally, a crucial term, and concept, used throughout this book requires some further explanation before its application to bilingual processing. This is the term, 'representation'. In sympathy with Jackendoff's once expressed reluctance to use the term to avoid too simplistic a notion of how something comes to be represented in the mind, the more neutral term (mental) 'structure' can be used as the description of what is often called a representation. We will follow Jackendoff's conventions particularly in using 'CS' rather than 'CR' for conceptual representations, 'PS' rather than 'PR' for phonological representations, and so on (Jackendoff, 2002, pp. 20, 199). However, we will also use 'representation' to talk about any kind of cognitive structure, so it is important to keep in mind the fact that, in this book, the two terms can be treated as interchangeable.

As mentioned above, at a theoretical linguistic level of description, a representation is defined as an abstract structure; a noun phrase is a syntactic structure, for example, and is itself composed of certain clearly defined properties or syntactic 'features' each of which may also be called structures (or representations). Put another way, a noun phrase structure may be thought of as a type of representation and so can the individual properties that go to make up a noun phrase, including the representation ‘noun’ and the properties that the noun structure is itself composed of. The exact linguistic-theoretical definition of what a noun or a noun phrase is will depend upon the preferred syntactic theory, i.e. the chosen narrow theoretical framework, and so is not defined by a broader overarching framework. All of these elements are representations and they are also highly abstract and therefore their definitions do not immediately invoke their processing properties.

6. Chapter summary

This chapter began by discussing context in general but quickly narrowed down the discussion to the topic of this book, namely internal context, in other words the processing activity with its informational content that provides at any given moment the basis on which bilinguals interpret and produce utterances. This topic needed some elaboration and led on to a discussion of general models of the mind, of different levels of explanation that need to be clearly distinguished, namely the theoretical linguistic, the psychological, and the neural levels. This also involved a discussion about broad and narrow theoretical frameworks used to guide research. The chapter finally concluded with a general introduction to the approach to be used in this book designed to guide the more comprehensive and detailed explanation of how context is processed in the minds of bilinguals and multilinguals but not excluding those who only speak one language, namely the approach called the Modular Cognition Framework, the topic of the following chapter.

CHAPTER 2

The Modular Cognition Framework

1. Introduction

This chapter will outline the main features of the *Modular Cognition Framework* (MCF), giving an overview of the architecture of the mind and the role of language as developed by Sharwood Smith and Truscott and taking into account recent developments in the way the framework is being elaborated (see for example, Sharwood Smith & Truscott, 2014b; Truscott & Sharwood Smith, 2004). The framework presents the mind as a network of specialized interacting, collaborating systems. Subsequent chapters will show in more detail how this framework deals with the notion of internal context and what this means for our understanding of bilingual processing. It is relevant to note here that we have attempted, as much as possible, to align the integrated perspective that the MCF purports to provide with a range of theories, empirical findings and explanations from different domains of cognitive science.

In this second chapter, we will deal with how to define representations, the modular nature of the mind as set out in the MCF, its account of processing which will involve spelling out what exactly is entailed by processing, how development ('growth') takes place given this processing approach, the different ways in which knowledge is manifested, the nature of goals and self within the framework, the important part that affect plays both in online performance and in the growth and attrition of knowledge, and finally what we mean by 'context'.

Here in advance are the basic processing features of the MCF which will be explained over the course of the chapter. The following list of eight points should help to set the scene, always keeping in mind the fact that this is about cognitive, not neural architecture:

1. The mind is made up of individual systems each of which has a specific task. The specialized systems are called modules.
2. Underlying all mental activity is collaboration between modules.
3. Modules, even though their operating principles are unique, nevertheless share the same basic design.
4. Modules are all composed of a *store* that contains representations and a *processor* that builds and processes structures in its store according to its unique principles.

5. Representations are also called 'structures' as indicated by the 'S' in their names (AS, CS, PS etc.).
6. Being able to map cognitive functions onto the architecture of the brain is held to be very important but is not straightforward.
7. The collaboration between (mental) modules is made possible by connecting systems called *interfaces*. Interfaces connecting the different stores in different modules enable the association and coactivation of structures in different stores.
8. No extra modules are required to explain multilingual cognition: Individuals use the exact same set of cognitive systems and interfaces irrespective of how many languages are available to them.

Some readers might initially ask themselves if such a theoretical framework as proposed in this book is really that useful at this point in the development of the field since so much research has already proceeded quite fruitfully without one. We have a robust response to this. This framework is designed to fill an explanatory gap, in fact what are whole series of unresolved questions and assumptions. It sees much research into language acquisition and language performance, whatever the focus is, as lacking a currently plausible, reasonably well-defined basic model of how the mind processes language in the first place, how memory works and how processing mechanisms control the manner in which languages are used, acquired and lost. A lot of good research has indeed been done in the areas referred to without such a model but that is no argument for not having one and actively using it when making hypotheses and explaining empirical findings.

We should also add that there are other candidate frameworks and general perspectives available which are often referred to in general terms or in some cases are simply assumed and, although we leave full-scale comparisons aside, we will nevertheless still make references to these alternatives during the course of the discussion. However, as the reader will immediately appreciate, we consider that research on many of the phenomena that they individually claim to explain can be even more usefully integrated and investigated further within an MCF perspective.

2. What is a representation?

Following on from the discussion in Chapter 1, linguistic structures, which have been proposed at a level of description that abstracts away from time and space, will be defined in particular ways according to a given linguistic theory. However, as mentioned earlier, such definitions do not claim to locate a structure somewhere in the brain or even to refer to something that takes a longer or shorter time to produce or understand. That is the job of researchers working with other levels. At levels of description that do involve space and/or time, and relate representations to psychological or neural function, redefinition or at least further elaboration will be necessary.

2.1 Mental versus neural representations

Neurally speaking, for example, Damasio has described what he calls a dispositional representation as “a potential pattern of neuron activity in small ensembles of neurons” which “may be distributed over a number of different locations in the cortex” (Damasio, 1994, pp. 102–105). As far as the psychological level of description is concerned, graphic displays showing the way different components are related to one another need not, and often do not represent the way their neural instantiations are organized. However, temporal features of mental architecture must be carefully explained, since psychological accounts must account for temporal organization, why, for example, certain tasks take a longer time to complete than other tasks as observable in given experimental data or why certain types of knowledge are slower to develop than others. This means effectively that a representation becomes something that can change over time, gradually or rapidly, and it can be more or less ‘accessible’ in real-time processing, a notion that can manifest itself in experiments in slow or fast response times.

Take, for example a composite representation which a given theory accounts for as being made up of a set of features. In the MCF, these features are themselves representations and as such they can individually have different degrees of availability during online processing. This makes a psycholinguistic representation of a noun with the various nominal features of which it is composed, a more flexible version of its fixed equivalent at a more abstract linguistic-theoretical level. It is perhaps tempting to import representations from abstract ‘time-free’ linguistic theory unchanged without considering whether adjustments or additions might be required to make clear what a linguistic representation would look like in a different theoretical context, namely where properties specific to processing and development in real time might be involved.

2.2 Representations as knowledge

Another issue with regard to any specific kind of representation is their status in the mind as a whole. For example, ‘linguistic’ representations may be conceived of as a type of ‘cognitive’ or ‘knowledge’ representation. Setting aside all epistemological controversies about the nature of knowledge, linguistic representations can be treated as part of an individual’s total knowledge at any given moment, irrespective of any truth value that may be attributed to that knowledge. Used in this sense, it therefore includes knowledge that may also be described as a belief for which there is little or no evidence and also as a belief that is maintained by the individual despite overwhelming evidence that it is 'false knowledge'. In all cases, the knowledge is built out of representations. This includes (a) knowledge that is available for conscious inspection and manipulation and also (b) implicit, intuitive or 'underlying' knowledge that may not be accessible to awareness, either ever or at least not at a given moment in time.

The knowledge that individuals have about the world and which can feature in their conscious thought processes has its base in the conceptual system. In other words, thinking involves the activation of meanings, conceptual representations, in a manner that allows them to be deliberately called up and manipulated. Conscious learning can proceed in this manner so that an individual's encyclopedic knowledge can be adapted or increased. A particular type of metacognition is *metalinguistic* knowledge, in other words knowing facts about language. Note that this is not the same as the knowledge that drives fluent unreflecting performance in a language, much of which is subconscious and intuitive. Put another way, it is perfectly possible to have a large amount of factual knowledge about a language, particularly its grammar, but at the same time little proficiency in actually speaking and understanding it. Facts about languages are essentially no different from facts about transport systems, the geography of South America or the neighbors next door. All of this knowledge that can feature in an individual's thought processes must be distinguished from their knowledge that also is located in the conceptual system in the form of conceptual structures and is currently unavailable, not yet available or never available for metacognitive processing. We will continue a discussion of metalinguistic processing in Chapter 5.

2.3 Representational schemas

The main locus of what we generally think of as knowledge is the conceptual system of MCF. However, knowledge typically includes associations with representations in other systems, for example in perceptual systems. To take the example of apples, knowledge about them will inevitably be formed out of a network of associations, e.g. between conceptual structures representing the meanings, and various perceptual ones (representing the look, feel, appearance and smell of apples for example). Further types of representations will be also involved, like linguistic representations: Bilinguals will have ones appropriate for either language. These networks of representations are now called *schemas* in the MCF. Schemas are formed when connections are made between representations across different modules and, as they become more established and hence more readily available, they provide an efficient way of making instant sense of experiences that are similar to previous experience. Schemas are not fixed and may undergo continual adaptation.

How, in the MCF, these representational networks arise, develop and operate online will be explained in more detail later. Figure 2.1 shows a network, i.e. schema of 'apple' representations that is only the barebones of a fragment of how all the various associations would actually be represented (see further discussion of the different types of structure below). This is really just to give a foretaste of a more detailed account. All such representational structures and the schemas that link them contribute to the existing internal context that is available to an individual for linguistic processing at any given moment. These representations are all items occupying the memory stores of the various modules. For example, the visual structures that are associated with the concept APPLE are located in the memory store of the visual module. APPLE itself is a conceptual representation located in the memory store of the conceptual model and so on. Finally, the resources that together make up the internal context of linguistic processing for a given individual also include the processors that manage the various representations such as those displayed in Figure 2.1.

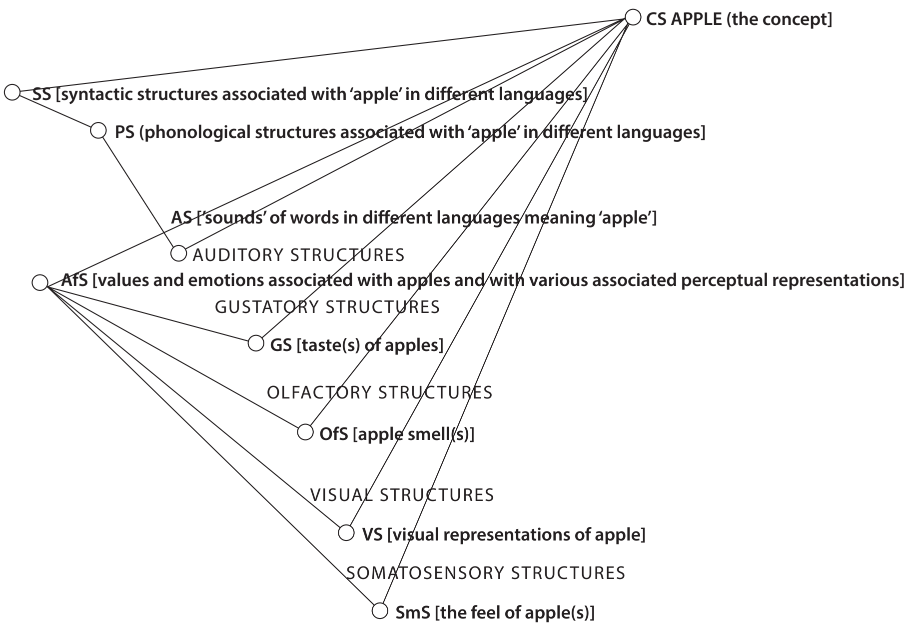

Figure 2.1 Representing 'apple' (a fragment)

3. Modularity

As was briefly described in Chapter 1, and as the name implies, MCF assumes a modular architecture. Thus, some discussion is needed on the nature of modularity and some issues that it raises.

3.1 Modularity in brain and mind

While non-modular connectionist models continue to play a lively role in the debate about how mind and brain are organized, the view that the mind is composed of a set of functionally-specialized modular systems each of which therefore has a specific task has gained a great deal of acceptance, the questions still being what these modules are exactly, how they work together and where language fits into the scheme (see, for example, Barkow, Cosmides, & Tooby, 1992; Barrett & Kurzban, 2006; Carruthers, 2006; Dupré, 1987; Fodor, 1983, 2000; Gazzaniga, 1992, 1998; Gardner, 1993, 1999; Hirschfeld & Gelman, 1994; Jackendoff, 1987, 1997; Kurzban, 2010; Pinker, 1994, 1997). As the MCF espouses a version of modularity, we will now focus on this type of perspective. This means we will not include much if any discussion about how connectionism might or might not solve the cognitive or neural issues that we will be discussing in this book although it certainly merits discussion elsewhere. We would still point out in some general sense MCF architecture *is* connectionist and, as suggested earlier does things that connectionist networks also do. In other words, it embodies at least some basic principles and processes that also characterize connectionism and emergentism. At the same time, apart from being a representational, information-processing account of the mind, the framework imposes constraints that these other approaches find unnecessary and unjustifiable. We of course do not (see Sharwood Smith & Truscott, 2014b, pp. 2–8, 142; Sharwood Smith, 2017b, pp. 11–16; Sharwood Smith, 2019a; Truscott & Sharwood Smith, in press).

Modules, in the sense that we are interested in, are commonly considered products of evolution; in other words they are innate (but see Karmiloff-Smith, 1992). Functions like vision and language have clear survival value, so the development, through natural selection, of specialized systems to carry them out is quite natural. Efficient execution of a specialized function requires specialized encoding, so distinct representational codes are a natural feature of such systems, as is a degree of isolation from other systems using other codes and serving other functions. The extent and nature of the isolation are important research questions. Some separation is necessary, but there clearly cannot be a *system* in which components are entirely separated from one another.

The brain offers a straightforward example of modularity (see Bertolero, Yeo, & D'Esposito, 2015; Dehaene, 2011; Gazzaniga, 2011). The visual system is distinct from the auditory system for example. Each has its own locations and pathways in various places in the brain that can be easily identified even when both share some part of the same anatomical area. Take just one example, the component of the brain called the hippocampus. The hippocampus is a small organ within the medial temporal lobe but it does not just have one single function and it is divisible into subcomponents. In other words, it has its own anatomically and functionally distinct regions; for example, the ventral (lower) region is involved in affective processes and the dorsal (upper) region is involved in the learning of conceptual information[1] and the same can be said of other major components of the brain. Two functional systems may share pathways leading in and out of one organ, in this case the hippocampus, but this kind of observation hardly justifies thinking of the brain as an integrated system without the need for modularity. On the contrary, everything we know about the brain strongly suggests a complex, modular system. This still leaves open the question of if, where and how these various subsystems interact.

Mental modules may be described at a greater level of abstraction than neural ones and the architecture of the mind can be described in somewhat less complex terms but, in the MCF, the modular principle is maintained just as strongly for this level of description as well. However, the way in which cognitive functions can be related to neural ones is not straightforward. At the same time, it is important to develop accounts that facilitate such relationships as much as possible. In the course of this book, we will be returning to this question with regard to specific aspects of cognitive functioning but our focus will always remain directed towards explaining *cognitive* aspects of bilingual processing.

3.2 Modules in MCF

The way the MCF has been developed since 2000, mainly in its MOGUL manifestation, has kept consistently to the same set of expert systems – the modules – each consisting of a dedicated *processor* and *store* plus *interfaces* that connect them up with one another in particular ways. This is the basic design abstracting away from the intricacies of neural tissue and the design is valid for all modules. In fact, varying the number of modules is not an issue: There may be good arguments to split some of them up but they will all conform to this basic design of a processor, a store, and connecting interfaces.

1. The precise identification of various functions is still a subject of lively debate, especially with reference to its role in cognitive decline (see, for example, Evans et al., 2018).

What distinguishes one modular system from another is its function, which is shared by none other, in other words it is a *unique* function. Hence, the conceptual system, which has been mentioned several times already, is the system where all meanings, i.e. conceptual structures (CS), are stored. The conceptual processor is designed to process only CS and using principles that are not shared by any other processor. This means that the organization of a meaning is different from the way a visual representation, say, is constructed, or indeed any other type of representation. In the past this has been described using the simple digital metaphor: An MP3 file, for example, is currently a way of storing sound and is structured differently from a JPG visual file which is constructed according to different principles and is designed for the storage of images. You need a different program depending on whether you wish to run the sound file or display the image (see Sharwood Smith, 2017b, p. 9). In a similar manner, an auditory structure (AS) stored in the auditory store within the mind's auditory system, is constructed and processed by the dedicated auditory processor. A visual structure (VS), like the visual representation of an apple, sitting in the mind's visual store, is constructed and processed by the dedicated visual processor. In other words, an AS is built differently from a VS and each is also processed differently, i.e. by its own dedicated processor.

The mind's systems may be subcategorized into perceptual and non-perceptual modules. The perceptual systems that have been proposed thus far are the visual, auditory, gustatory (taste), olfactory (smell) and somatosensory (roughly 'body sense') modules. These can be represented as forming an outer ring as the first ports of call for stimuli flowing from the outside world via the sense organs, a kind of 'perceptual portal'. These modules are richly interconnected, every one of them having an interface with all the others as displayed in Figure 2.2). As will be explained shortly, this means if a representation of one type is activated, it will easily trigger associations with other perceptual systems: At its most dramatic, coactivation of associated perceptual structures can lead to synesthesia where, for instance, an individual experiences a sound as also having a color. We refer to this integrated set of perceptual modules, providing the system with a picture of the world, as *perceptual output structures*, or POpS.

Non-perceptual modules in the MCF can be conceived of as existing within the perceptual portal and provide further, deeper processing of environmental input and the development of the interpreted world. These inner modules consist of the conceptual system, the affective system, the motor system and finally the linguistic systems (see Figure 2.3 where interfaces with the other modules have been omitted, as have the linguistic systems). The affective system is associated with emotional processing but also with associating positive and negative values to representations in other systems. These inner systems will each be further described later but we will begin first with the linguistic ones.

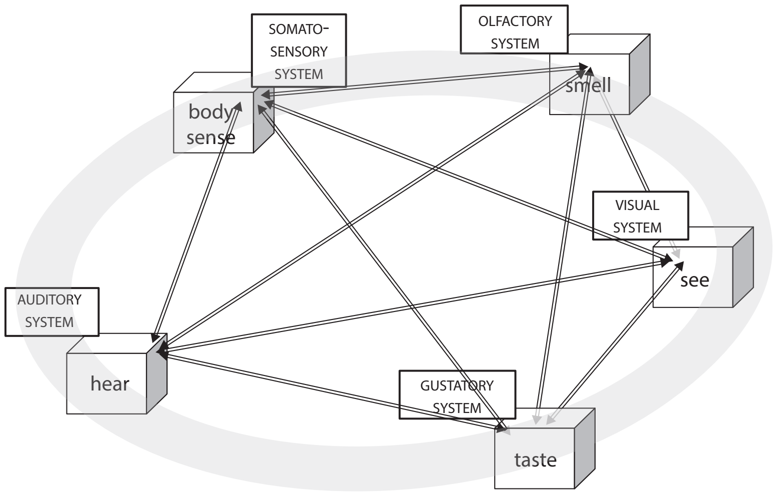

Figure 2.2 The perceptual portal

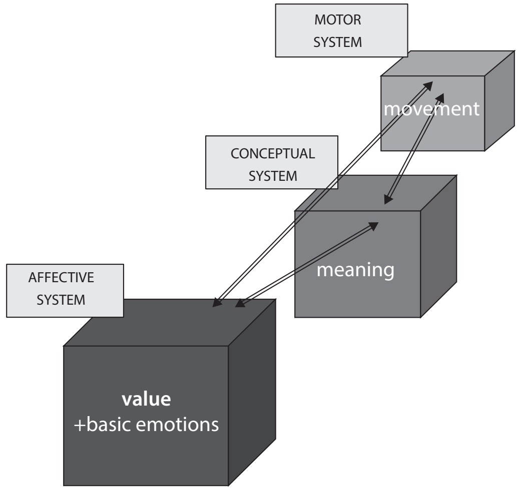

Figure 2.3 The 'inner 'modules'

We should add an aside here, that is to say, something that will be mentioned again, namely that we currently think there is a good argument for having an additional module beyond the perceptual portal, alongside those in Figure 2.3, one that deals with spatial representations. These would be called spatial structures in the MCF (SpS). They do not figure in the classic MCF/MOGUL architecture described previously. The architecture has always been flexible to have other modules added to it as long as there are good supporting arguments and evidence from research to back it up. We feel it is best, however, to attempt parsimonious versions where there is no such support.

3.3 Locating language within the modular mind

In the MCF, among these expert systems there are two that together define what has been elsewhere termed the language faculty. As already mentioned, language is handled by the complete set of systems that make up the mind and not just the ones that are specific to language. Most people will associate the language faculty with the classic Chomskyan autonomous syntax version. At the most abstract level of description, the current Minimalist account of the language faculty as a single module may well seem to be the most parsimonious one. However, since we are engaging with another level, the psychological, real time level, Jackendoff's approach seemed considerably more attractive as it is easily interpretable at both levels of description (Jackendoff, 2002). It also subscribes to the same basic principles of learnability and accompanying explanation of child language acquisition as its mainstream equivalent.

Although MCF differs in certain respects, it is nevertheless very close to Jackendoff's approach. In other words, this faculty or, as we prefer to call it, this 'core language system' that is species-specific and concerned only with linguistic structure in its narrowest sense, comprises two separate systems, syntax and phonology (see Figure 2.4). This means, for instance, that the traditional triple structure defining a word representing, that is its phonological, syntactic and semantic properties, is, in MCF (and Jackendoff) the product of two interrelated *linguistic* systems (in the sense just explained), i.e. the phonological and syntactic modules, plus a third, generic system, namely the conceptual module. This underlying structure, or rather set of structures can be displayed straightforwardly as follows, with the two arrows representing the interfaces between modules: PS⇔SS⇔CS.

The phonological structure (PS) of any linguistic construction, simple or complex, is itself associated with generic sound structures, in other words a (simple or

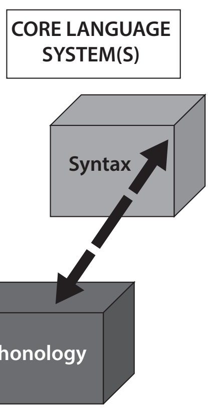

Figure 2.4 The core language system

complex) AS, stored, processed and activated in the perceptual portal, in this case in the auditory system. Written language of course is also processed in the core language system but via the generic visual system. Letters and other orthographic marks are first processed as generic visual patterns before further associations grant them the status of *linguistic* visual signs. Everything coming from the environment is processed first by the generic systems sitting in the perceptual portal. The same goes for the processing of sign language. Much of what is written by opponents of the modular view of language has to do with the large areas of language that are processed outside the core language system, especially the conceptual system. We should also add here a reminder that a number of alternative linguistic accounts can be worked into the explanations of how the linguistic processors work provided they are or can be made compatible with the MCF's modular processing architecture. This is in line with the status of the MCF as a theoretical *framework* rather than something which entails a fixed choice of one particular theoretical account of the phenomena in question.

The logic of modularity is that specialist systems carry out their dedicated function with only limited input from the rest of the cognitive system. The limits can be on which other modules provide direct input to a given module and/or on what form that input takes. In the MCF the 'what form' question is about the nature of the interfaces, which serve only to activate coindexed representations across modules (see the next section). The other constraint comes from the selective connections (i.e. interfaces) among the modules. For the case of human language, the function of the faculty is to serve as a sophisticated mapping between sound and meaning. This means, first, that the two inherently linguistic components, PS and SS, must be connected to one another, as described above. In regard to their external connections, it means that the PS/SS system must connect at one end to conceptual structures, the home of meaning, and at the other to the modules that provide the input to language processing – auditory structures for speech and visual structures for reading and signing.[2] There is no apparent reason to hypothesize additional connections for the inherently linguistic modules; interactions with additional modules are done via CS, VS, and AS. The situation is depicted in Figure 2.5.

The framework requires that the concept of language as opposed to specific subsystems like phonology and syntax cannot remain vague. In other words, in outlining the mental architecture supporting any language activity in the mind (and brain), the connections that reach outside the specifically linguistic modules

2. We have simplified the discussion here by leaving out PS connections to somatosensory structures, for the case of Braille, and motor structures, for the physical output of the language faculty.

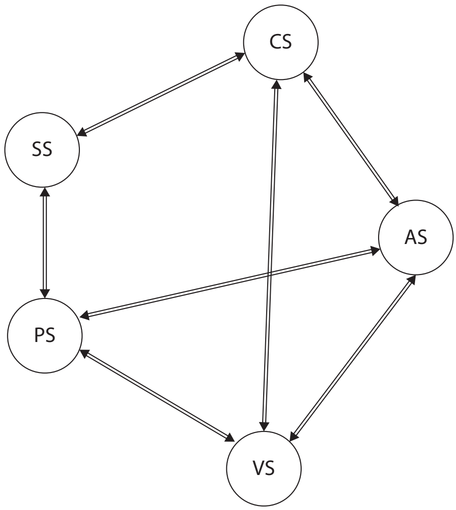

Figure 2.5 Connections of the linguistic modules

and the systems they interact with will have all to be specified in some detail. In MCF, the *conceptual* system, for example, handles all abstract meaning and not just the pragmatic and semantic meanings associated with particular phonological and syntactic structures. The conceptual system may or may not be shared by some other species; other systems definitely are although the way they are internally organized will of course be different. This includes many of the perceptual systems and also those that handle affective and motor behavior. These non-linguistic systems are indeed associated with linguistic function – they are all important for explaining language – but they are also associated with many other functions. The *affective* system responsible for appraisal and emotion is very important for understanding linguistic behavior but it also collaborates with most other modular systems. Similarly, the *motor* system not only governs the articulation of speech and gesture but other movements of the human body. In other words, language even though it is partly driven by systems that no other species possess is ultimately the product of the whole mind. This is particularly important when considering the processing of context.

3.4 Generic sound and generic meaning

Three modular systems in MCF outside the two specifically linguistic ones (i.e. phonology and syntax) will become especially important in the discussion of internal context. The first two are the *auditory* system and the *conceptual* system. Apart from their mutual interface connection, these two systems both have direct interfaces with modules that process linguistic structure. They are also both involved in associations that are not directly related to language and can therefore be treated as generic. The auditory system processes all sound representations and results in the creation of generic auditory structures (AS). As regards all perceptual input coming via the acoustic channel, i.e. sound patterns in the environment that are perceived via the ears, the auditory system represents the first port of call. In auditory memory are stored auditory representations that result from this input. A subset of those representations will go on to be processed as speech by the phonological system, which is constantly on the alert to perform this task wherever it can.[3] Effectively this means in simple terms that what is regarded as 'phonetic' may be used to describe those auditory representations that happen to be interpretable by the phonological system. This means they are encoded auditorily in the same way as any other sound representation. In other words, they gain their linguistic status *solely by virtue of the interface with representations in the phonological store*. The sound of a distant foghorn and a particular vowel sound, say, are both encoded in the auditory module as auditory structures. Vowel status is established when one of the auditory representations is interfaced (coindexed) with a *V(owel)* representation in the phonological system: The following structural chain represents the linguistic status assigned to a given auditory representation: AS⇔PS.[4]

The case of conceptual structure is a similar story. The conceptual store contains abstract meaning representations, i.e. CSs (conceptual structures). A considerable number of these will be coindexed with a linguistic structure, that is, via the syntactic/conceptual interface, thus: SS⇔CS.[5] In other words, many of these meanings will be expressible in one or other of the language systems possessed by a given individual. However, as mentioned earlier, there will certainly be CSs that are not associated (or yet associated) with a linguistic structure. A smell, a taste or a sound, for example, may be meaningful without any available way to describe it in language. This is why the conceptual structure may be termed 'generic' because the conceptual system handles generic meanings. How then does this relate to language? Just as phonetics falls within the generic domain of the

3. Some sounds will be further processed as music (see for example Jackendoff & Lehrdahl, 2006; Lerdahl & Jackendoff, 1983).

4. This can be spelled out as follows: AUDITORY STRUCTURE – INTERFACE – PHONOLOGICAL STRUCTURE.

5. It might be argued that phonological structures also connect up directly with the conceptual structures (Jackendoff, 1987). In the MCF we prefer to think that here conceptual structures are actually linked up via the AS⇔CS interface not to the phonological system but to the auditory system where patterns of rhythm and changes in volume and pitch are first processed before being further processed as linguistic (prosodic) representations (Sharwood Smith & Truscott, 2014b).

auditory system, so too semantic and pragmatic meanings are also written in a code that is not specifically linguistic but rather shared with other *non*-linguistic meanings. A CS gains its semantic or pragmatic status by virtue of being coindexed with a SS or PS. As regards semantic CSs, the association between core meaning and linguistic structure is relatively simple and straightforward as illustrated in the PS-SS-CS chain: /apl/⇔N⇔APPLE. Pragmatic meanings, on the other hand, are, unsurprisingly, more complex. The characterization of both semantics and pragmatics, traditionally 'linguistic' categories, as 'non-linguistic' may be disconcerting for some. However, it is still perfectly legitimate to describe language in terms of a traditional sound-meaning pairing as a tripartite structure of PS, SS and CS as was illustrated when discussing the structural composition of a single word. Semantic and pragmatic structures are linguistic by proxy, that is, by their association with the linguistic modules. The next few sections deal with other aspects of the conceptual system in preparation for the fifth chapter devoted to bilingual representation.

4. Processing: Activation and memory

The number of modules that make up the mind as a whole is not absolutely fixed and there may be reasons for more than the ones currently proposed. At any rate, the mind is presented as a network of collaborating modular systems each with their specific function but all operating according to the basic design of processor, store and interfaces with other systems. Although the basic operating mode of the modules together is, as mentioned earlier, heterarchical with no central supervisory system, the modules' processors themselves will certainly embody hierarchical principles.

As will be clear from subsequent chapters, all context is processed through different kinds of collaboration between modules. This naturally poses the question: How do they collaborate? To answer this question, it is necessary to look at how processing and storage work within a given module and how much of what happens inside such a system can be shared across the system as a whole for active collaboration to take place.

4.1 The story so far

Now that the nature of knowledge representations within the framework has been established, the basic processing features of the MCF will now be outlined. First, we reiterate below, for the reader's convenience, a summary of the main points listed at the beginning of this chapter.

The mind is made up of collaborating modules each of which has a specific task and their own unique set of operating principles. Nevertheless, these modules share the same basic design. They are each composed of a *store* that contains representations and a *processor*. Representations in the MCF are also called 'structures' as indicated by the 'S' in their names (AS, CS, PS etc.). As regards the complex question of how cognitive functions should be mapped onto the architecture of the brain, an important goal guiding the design and instantiation of MCF is just to facilitate this as much as possible by keeping up to date with the relevant brain research.

Modules do not exist in a vacuum but are connected up in various ways. Interfaces between module stores allow collaboration by enabling different types of structure to be associated and coactivated in parallel. Finally, no extra modules are required to explain multilingual cognition because the exact same set of cognitive systems and interfaces subserve one or many languages equally well.

4.2 Activation within stores

At the heart of all processing is the notion of activation. It is impossible to talk about activation without also discussing memory because it is in a given memory store that activation takes place. Although a store can, especially where the linguistic modules are concerned, be thought of as a specialized lexicon, from a psychological, processing perspective, stores can be regarded as a dedicated memory area. In each case, it is a repository of the structures (representations) specific to that system: A visual store will contain visual representations and a syntactic store will contain syntactic representations.

These two types of representation will be structured differently because each store is organized according to the principles enshrined in the processor. The visual processor ensures that visual representations are assembled according to the principles of vision. By the same token the syntactic processor ensures that syntactic representations are assembled according to the principles of syntax. In each case a representation in a store can be a single structural property – a 'primitive' of the module – or a complex of more than one structure associated or 'bound' together. The assembly, the combining of representations to form larger structures of the same type (visual or syntactic in the above examples), is the function of the module's processor. Once structures in the store have been activated, the processor can then manipulate them one way or the other following its 'in-house' principles. New structures may be formed as a result of this processing activity and the total number in the store will consequently increase.

There is more to be said about activation within stores but first, who or what defines what these principles of assembly are? Strictly speaking, this is not the task of a broad theoretical framework like the MCF but rather the task of the researchers working in specific areas of cognition such as vision or syntax according to their own theoretical preferences. Since the book is about bilingual processing we will accordingly illustrate the framework using our own theoretical preferences where appropriate and otherwise identify established views in other areas of cognitive science to fill out details in areas where we are not proficient or at least less proficient.

4.3 Working memory: The 'state' view

Given that a store in processing terms is a memory store and its structures (representations) at this psychological level of description the contents of a given memory store, we have to turn to the relevant research domain. In other words, defining memory requires commitment to one or other ways of viewing memory discussed in the relevant psychological literature. This includes situating within the framework the difference between different types of memory or memory states that have been proposed such as 'long-term' memory (LTM) and 'working memory' (WM). It also includes situating other such concepts that crop up regularly in the psychological literature such as episodic memory, semantic memory, visual memory and so on and so forth. In MCF, we have adopted an approach to working memory which is associated more with Nelson Cowan than Alan Baddeley, the latter happening to be, at least so far, the preferred perspective in much psycholinguistic work (Baddeley, 1986, 2007, 2012; Baddeley & Hitch, 1974; Cowan, 1993, 2000, 2005). This means, in particular, that working memory is defined not as a separate component but in terms of given representations in a given memory store being *in a currently activated state*. The view of WM as activation has many supporters nowadays apart from Cowan (see Cantor & Engle, 1993; D'Esposito & Postle, 2015; Engle, Cantor, & Carullo, 1992; Fuster, 1995, 2015; Miyake & Shah, 1999; Ranganath & Blumenfeld, 2005; Ruchkin, Grafman, Cameron, & Berndt, 2003).

What we have described to this point – activation within individual modules – can be called *local* WM. The framework also allows for a broader variety, which corresponds more closely to what is commonly meant by the term 'working memory'. This is *global WM* (GWM), the synchronized activity of various modules, centered on the perceptual, i.e. on perceptual output structures (Truscott, 2017). When the various local WMs act in harmony, with a particular representation as the focus, the focused representation acquires an exceptionally high current activation level and with it great influence throughout the system. It also becomes, by virtue of the extreme activation level, the object of awareness. This latter point is a consequence of the *Activation Hypothesis* (Sharwood Smith & Truscott, 2014b;

Truscott, 2015a, 2015b): A representation is the object of consciousness if and only if its current activation level is exceptionally high. It should be noted that working memory, both local and global, is not a 'real thing' in the framework but rather a (very) useful way of referring to the way that highly active representations influence processing. We will further develop the MCF view of working memory and consciousness in Chapters 10 and 11 respectively.

In bilingual processing, at a given moment, syntactic representations (SS) and phonological representations (PS) from more than one language may be activated in their respective stores and compete with one another for what is commonly, and in our view misleadingly called 'selection' since this implies an internal supervisor or homunculus (see 4.2 in Chapter 1 and especially the discussion in Section 2 of Chapter 6). Competition revolves around which structures in a given module have been activated so strongly as to be able to overcome others, i.e. 'competitors' or 'candidates' that have also been activated. Very strongly activated structures in individual module stores therefore have an increased chance of taking part in the current online assembly of larger more complex representations: These are necessary for the current cognitive task in hand. Structures with lower degrees of activation and so not making it into the assembly process gradually lose their activation level and, as it were, sink down to become to all intents and purposes 'inactive'. In other words, what is often referred to as 'long term' memory (LTM) is a different way of referring to all current items in a given memory store when they are inactive. What is termed 'working' memory (WM) refers only to specific items in a store that are currently in an activated state. In actual fact complete 100% inactivity is a convenient theoretical notion. This means that in reality activation may be regarded as something that is constantly varying across a large range from 'very minimal' to 'intense'. The mind never rests completely.

4.4 Interfaces

So far activation has been discussed as something happening inside a module: While activated, various simple representations such as syntactic (lexical) categories like *N(oun)* and even simpler ones like the grammatical features *plural* or *feminine*, can become associated in various configurations to form more complex representations and these in turn may be assembled further to form even more complex ones as well. The possible configurations permitted are determined by the internal principles of the module in question. The resulting complex representations are all of the same type, i.e. they are written in the same code, the code of the module. There is, however, another type of association, the one that links representations of different types *across* modules. Modules in a modular system are useless if they cannot collaborate and collaboration that allows representations of one type to be associated with another type is made possible by the existence of interfaces.

Interfaces are very simple processors whose function is to form associations across memory stores and when a structure in one store is activated, to co-activate their associates. Association is not the same as the combining of structures that takes place within a store to assemble more complex representations written in the code of the module in question. For example, since a visual representation is encoded in visual code and an auditory representation is coded in auditory code, it is not possible to combine the two in the same way. It is however possible to associate them in another way, thanks to the interface existing between the two modules in question (see Figure 2.2), so that when one is activated the other will also be activated in parallel. In this way, the sight of an aircraft and the sound of an aircraft will not be treated as completely independent and unrelated but as somehow 'belonging' to one another, that is to say without the aircraft image actually becoming a sound and vice-versa. Various other relevant representations such as the conceptual representation of the meaning of an aircraft will be similarly associated so the simple activation of the sound of an aircraft alone will trigger the coactivation to the other associated structures via the appropriate interfaces. This is what was meant when we said that internal context will involve a whole network of associated representations.

In this way, interfaces that connect one or more modules allow an association of and subsequent coactivation of various representations of different types. This should provide some insight into how it is that, on perceiving via the ears a particular pattern of sound waves, the meaning APPLE, for example, pops into your mind. Despite the apparent instantaneous, meaningful response to the acoustic stimulus, what has actually occurred is the coactivation of a network of associated representations in different modules that culminates in the coactivation of a given conceptual representation (in this case the meaning of apple). In the collaborative process leading to this instant apple experience, the representations from the various implicated modules and written therefore in mutually incompatible codes have still remained quite separate and distinct from one another.

As indicated earlier, interfaces are represented with two-way arrows. The following example shows the interface between a given auditory structure (AS) and a conceptual representation (CS) whereby the sound representation can interact with a given meaning representation. In this way each representation can trigger the other one:

(acoustic input >) AS⇔CS

4.5 Coindexing

Nothing has been said so far about the actual interface mechanism that establishes and coactivates associations across interfaces. Take a simple example of learning the name of an object, *axe* for example. This can be in any one of the languages used by the individual but the following example will be an English one. When encountering any visual object, previously unnamed but now named by someone else, the following events will take place in parallel. The processing of the situational context including the visual display of this object, at the same time as linguistic structures are being activated in response to speech input containing the sound of the actual name of that object will allow associations to be made between linguistic representations and a conceptual representation. This association is established by assigning the same identifying tag to the currently activated conceptual representation and the currently activated linguistic representations. This tag is called an *index* and for the sake of convenience, we will imagine a given index as some random number. For example, the visual structure that represents in visual terms say an axe, might get an index 456.

In the axe example during on-line processing, the same identifying index (456) will be assigned to the phonological structure /aks/, the syntactic structure N(oun) and the conceptual (meaning) structure AXE.[6] On the next occasion these 456-indexed representations will for a second and subsequent times be coactivated thanks to the connecting interfaces. In other words, at least for the time being, a network of different kinds of representation will be activated in parallel once one of them is activated. On seeing an axe again, for example, the network will cause, amongst other things, the meaning (CS AXE) to be activated in the conceptual system. All of this can occur without any merging of all the activated structures into a single highly complex one written in the same code. Merging in this sense is not necessary for an effective account of grammatical processing. In the MCF, it is not even possible since the code in which structures in one module store are written is incompatible with the code in any other one. Each module collaborates, thanks to the indexing system, to cause this chain reaction, or, to be precise, this more or less simultaneous triggering of a representational schema.

Clearly one structure (representation) may have many indices: There will obviously be many more conceptual structures than AXE that are associated with N(oun) for example and N will also have multiple associations other than conceptual ones. For example, where a bilingual or multilingual is concerned there will be many different auditory, phonological and syntactic representations that participate appropriate to whatever language is involved. Words for axe in other

6. By convention, conceptual structures are written in uppercase letters.

languages, e.g. Polish *opór*, French *hache*, Vietnamese *riu* will not have identical networks although some structures will of course be shared. They should all be nouns, for example, and thus trigger the corresponding SS, i.e. N, but in some cases such as Polish where the noun is masculine, a gender structure (masc) will also be activated in the syntactic system. The main point here is that once indices have been assigned, associations have been formed and the associations will be co-activated on later occasions whenever one of the structures tagged with the index 456 is activated. This is far from the end of the story as will soon become apparent.

4.6 Resting levels of activation (RLAs)

Activation, as was mentioned earlier, is subject to different degrees of strength. This is hardly controversial and is generally assumed even in psychological accounts that are otherwise mutually incompatible. In any account, the mechanisms involved in strength of activation need to be specified. In the case of the MCF, any representation will have a given *resting level of activation* (RLA). The metaphor that underlies the notion of level is one of vertical space. If the memory store is conceptualized as a container, then the structures (representations) that it contains are, when not activated, viewed as being located at different vertical positions, i.e. levels in that container. When structures undergo activation, they, as it were, rise up to the upper area of the container. While in this elevated position, the activated structures are said to be in working memory. It should be emphasized that this is a spatial metaphor to represent what is simply a different state. Effectively the (metaphorical) upper level of the store can be called the working memory (WM) area of the store.

Using this metaphor Figure 2.6 shows the same two representations in both an activated and an inactive state: The second one has a higher resting level than the first so, if activated to exactly the same degree as in this particular example, the second representation will naturally achieve a higher, more dominant position in WM.[7] The degree of activation in a given situation is, however, never fixed and will depend on various factors. Of course, different metaphors are possible: Activation could equally be portrayed as a change in temperature or light intensity.

It is in the WM 'area' that the processor of the store can, during online processing, combine representations that have been made available to it as a result of activation into more complex ones (see also Cowan, Saults, & Blume, 2014; Oberauer, 2009; Oberauer & Hein, 2012). Within the store itself, smaller structures can

7. Paradis's (1993) 'activation threshold' expresses a rather similar idea but the rise/fall metaphor works in the opposite direction: Activation lowers the threshold whereas lack of activation causes it to rise.

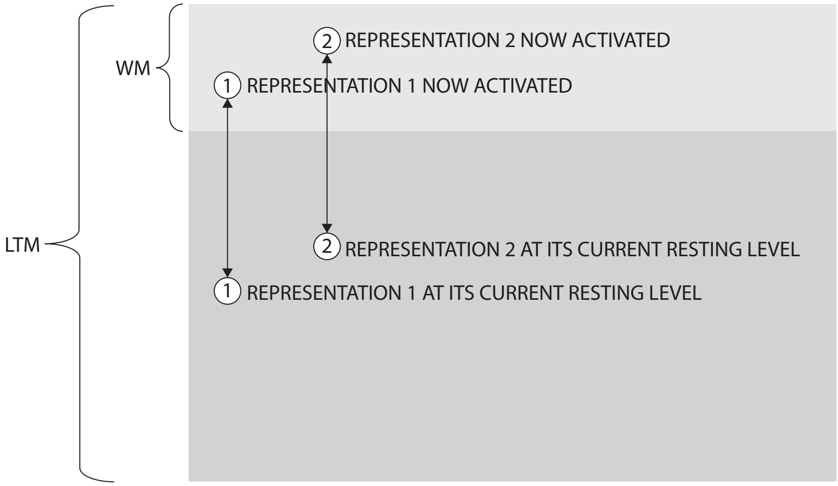

Figure 2.6 Working memory in MCF

be combined there to form longer and more complex constructions written in the same code. Although coindexation is not used to bind, for example, a noun with a case feature for the first time, associations inside modules are formed in essentially the same way as associations across modules, i.e. in working memory. A (more or less complex) syntactic representation may be coindexed with other cognitive representations in other modules and the respective interfaces function to coactivate all these other structures. In this way, as in the axe example, acoustic input can trigger a whole chain or network of associated representations to bring a given meaning in to the mind of the hearer. The same works in language production. The same array of structures is activated in the participating modules in parallel when the initial stimulus comes from the conceptual (meaning) system so as to convert the meaning into speech output except that, in addition, the appropriate motor structures (MoS) are activated in the motor system because these are needed to operate the organs of speech appropriately.

5. Growth

5.1 Acquisition by processing

One theoretical principle comes along with the MCF to explain the mechanism that dictates how any type of cognitive development takes place and new representations are formed. *Acquisition by Processing Theory* (APT) basically says that a representation is acquired and grows in strength as a result of processing. In itself, the principle is a well-known one and is shared across many theoretical perspectives including connectionist, emergentist and usage-based approaches and is also compatible with Hebbian learning (see for example the relevant discussion in Sharwood Smith, Truscott, & Hawkins, 2013; Sharwood Smith & Truscott, 2014, p. 99). The crucial difference is how it is interpreted within different theoretical frameworks.

Because MCF has a modular architecture, this means the growth of representations has to be explained taking into account that they may be written in different mutually incompatible codes. In other words, an MCF-specific version of this basic processing principle is required despite the fact that APT seems at first glance to be compatible with alternative approaches that reject the idea of a language faculty in accounting for cognition, even those that do not even recognize the existence of symbolic representations at all.

As has been explained, MCF accounts for activation across modules using the concepts of interfaces and coindexation such that representations in different modules can be activated together, each in their respective stores. This explains for example how a noise in the environment can trigger a meaning (and vice versa). This happens even though meanings, i.e. conceptual structures, are built according to conceptual principles and cannot be merged with any other structures that also need to be coactivated with them in order to make this act of comprehension possible.

The noise is a given pattern of sound waves which are picked up by the appropriate sensory system (ears, basilar membrane, etc.) and transduction of the acoustic stimuli produces a response from the auditory processor, activating a matching auditory structure (AS). Also activated via the appropriate interface are matching conceptual structures in conceptual working memory. This is the spreading activation process that explains how the perception of a noise in the immediate environment results in the activation of a given meaning. If the noise happens to carry a *linguistic* signal, say a word, the process will also involve the coactivation of structures in the core linguistic system that intervenes between the auditory store involved and the conceptual store where the activation of the CS is triggered. Noises with no names just follow a route that does not involve the core linguistic modules. The auditory system is also linked to the conceptual system directly so meaning-sound (CS/AS) activation can also take place simultaneously outside the indirect, language specific route.

As was mentioned earlier, in the building of a complex representation in response to some input,[8] there will be competition between activated candidates

8. 'Input' does not need to be input from the environment. Speech production provides one example of internal input where the activation of conceptual representation – the 'message' – triggers a number of structures across modules culminating in the articulation of the organs of speech.

in each store. In this competition, the winners are structures that are most strongly activated in the working memories of each store. Here a particular representation's resting level of activation (RLA) plays an important part. In the case of representations that are written in different codes but associated across interfaces (as in $SS^{456} \Leftrightarrow CS^{456}$), the specific RLA of a structure might be thought of as residing in its index or alternatively as a property of the representation in question. In fact, it is both: Both have their own RLAs that are based, as always, on their particular (co-) activation history. The SS representing N(oun) will inevitably have a relatively high resting level. The CS TRANSCENDENCE, for example, may represent a concept which has a rather low activation due to infrequent activation (unless you are a philosopher or theologian) and if you only talk about transcendence in your L1, say, the relevant interfaces between PS, SS and CS will have a different coactivation history depending on whether the PS/SS combination represents an L1 or L2 word. Even the structures associated *within* a module, i.e. written in the same code, e.g. *N(oun)* and *Acc(usative)*, may also differ in terms of their coactivation history, each having their own RLA: This becomes especially significant when talking about acquisition, and bilingual processing.

Acquisition, or 'growth' as we prefer to think of it, involves increases in resting levels of activation and or rearrangements of representations that are already in frequent use although in different combinations or with different functions (see, for example, Lardiere, 2008).

The question now is how exactly, in APT terms, do resting levels change? By default, the RLA of any newly created representation is in a 'low' position in memory, keeping to the vertical space metaphor introduced earlier. On subsequent occasions when representations are coactivated during online processing, they duly 'rise up' from their RLA; when activation ceases they gradually 'sink down' to an RLA *slightly above their original one*. In other words, the effect of activation is to give a small boost to their RLA hence bringing it fractionally closer to WM. This is a way of representing their increasing accessibility via-a-vis other representations in memory that may be potential rivals for selection on a given occasion. As just described, the changing strength of association can occur within a module or across modules. Further activation causes a boost to relevant RLAs and makes representations more accessible and hence more competitive.

5.2 Language attrition

What is usually termed language attrition strongly suggests processes of reduction and simplification. However, 'attrition' may also be seen as a type of growth especially as it does not in fact always result in a reduction of complexity. It can go the other way. Distinctions existing in the newly dominant language system may not exist in the system undergoing attrition but may begin to show up there: This introduces complexity where there was none (see, for example, Schmitt, 2002). In cases where there is absence of activation of a given structure in an attriting language, there will not be any boost to its RLA and over time if this persists the RLA will sink down making representations less accessible and less competitive thus gradually reducing the chances of them taking part effectively in future online processing. Also some aspects of languages in a modular architecture such as the MCF will have differing degrees of resistance to change with individual lexical items notoriously prone to attrition whereas certain aspects of syntax are claimed to be relatively resistant to change (see for example Chamorro, Sturt, & Sorace, 2016; Gürel, 2004). 'Lexical items' here would be interpreted as meaning the association between particular PS/SS chains with structures outside the core language system, notably a corresponding CS but also an AS (and VS in the case of the written mode). In conclusion, it should be emphasized that the attrition of a language system will not be a straightforward, gradual and simultaneous lowering of RLAs across the board.

One important point about MCF needs to be made at this juncture. A distinction needs to be made between *internal* frequency, that is frequency of processing within one or more modules and *external* frequency, namely the frequency of stimuli in the environment impacting on the senses. For example, someone may be *exposed* to a frequent word or phrase. However, unless appropriate representations in the syntactic module have been activated as a result of activity at the interface with some adjoining module and leading to new syntactic associations or the raising of RLAs, that external frequency will have no impact at all on internal *syntactic* growth. This has to be the case in order to explain, for instance, why frequency of exposure to given words and constructions does not by itself predict the timing and rate of acquisition, a fact that has been recognized for decades (see, for example, discussion in Gass & Mackey, 2002). A more dramatic illustration of this discrepancy between internal and external frequency would be if an individual were suddenly exposed to hours of radio broadcasts providing enormous amounts of 'input' in a language they did not understand at all: No one would then expect the miraculous acquisition of the language in question to take place while the language processing parts of the mind have gained little or no foothold in interpreting the stream of incomprehensible sounds.

6. The affective system

Inside the perceptual outer ring displayed in Figure 2.2, the other important module for the explanation of context processing is the *affective* system (see

Figure 2.3). Arguably its role in cognitive processing has been seriously underestimated although there is a growing realization that affect and cognition are so intertwined that they cannot be effectively studied in isolation from one another (see, for example, Damasio, 2000).

The affect module creates and handles representations that, unlike the perceptual representations, are entirely internally generated. Perceptual modules such as the auditory system create representations of the external context to match patterns of sensory stimuli made available (transduced from) the environment. Some of these will be speech patterns. Written and sign language will be processed via the general visual system as visual structures. The conceptual system matches auditory representations with its own conceptual representations, also entirely internally generated, some of which will be activated on a given online processing occasion to provide contextual meanings.

As a concept, affect is most frequently associated with emotion. Emotion has had various definitions in the cognitive science literature involving arousal, sometimes necessarily implying consciously perceived feelings, sometimes involving purely subconscious processes (see for example Damasio, 1994, 1999; LeDoux, 1996, 2012, 2015). Emotions have also been divided into core or basic emotions like fear, anger and disgust, and more complex ones like jealousy (Ekman, 2003). Some perspectives treat affect as being based on an evaluation or 'appraisal' system which we would regard as underlying emotions anyway (Lazarus, 1991; Scherer, Shorr, & Johnstone, 2001).

In the MCF, the affective module as currently conceived, certainly includes, as affective structures (AfS), both positive and negative values, which we will characterize as !pos! and !neg! respectively, the exclamation marks being the standard way to denote AfS representations in the MCF. These value representations will play a role in the processing of context with varying degrees of intensity. The association of these AfS with other cognitive representations in different modules greatly influences activation levels throughout the system and therefore constitutes an important part of internal context during processing. In particular the association of affective structures to auditory, visual and conceptual structures will turn out to play a vital role in controlling language production and comprehension in bilingual performance.

At the moment, in current interpretations of the MCF framework, there are no interfaces between the affective system and the two core linguistic modules, so, in other words, no direct associations between affective structures (AfS) and either PS or SS. This isolation of linguistic structures, PS and SS from affect need not necessarily be the case but the parsimonious view is taken that linguistic processing, where it is influenced by appraisal and emotion, can still be explained without these direct interfaces. There may also be some evolutionary advantage in having linguistic processing relatively uncomplicated by affective associations but that remains a speculation at the moment. At any rate isolating the core language system from appraisal and emotional content in no way affects the strong influence of these two aspects of the affective system on language as a whole.

To sum up, as on-line processing proceeds, the degree of activation of all representations will be in some way continually affected by the value currently associated with them. Affect plays a vital role in determining what in the context is important such that representations with a relatively low RLA may get a temporary boost and become more competitive whereas other representations with a relatively high RLA but lacking this boost may lose their competitive edge. This will be especially important in explicating bilingual processing where languages need to be kept apart or occasionally switched during online performance. In other words, the values that the affective system associates with representations in other modules are not fixed: Where, for example, in some ongoing situation, a change occurs and results in something *less* important suddenly appearing to be *more* important, this shift in perception is reflected in an adjustment to an affective structure (AfS) linked to a CS: This adjustment leads to changes in the strength of the CS affecting the currently activated schema as a whole.[9] In this case, it can cause a switch to a language that has now, as a result of the altered activation strength of the CS that determines which language should be used, become more important than the one being used up to that point (for further details see; Sharwood Smith, 2017b, 2017c, 2019b; Truscott & Sharwood Smith, 2017).

7. Goals

Goals are, almost by definition, essential in all that we do, including language use of all sorts, so they necessarily have a place in a broad framework like MCF. If we think of a goal as a representation of a possible state plus the information that this state should be attained, there is little in human behavior that cannot be considered goal-oriented. But our concern is with the relatively sophisticated and relatively explicit goals for which the term is more commonly used. Even narrowing the field in this way leaves us with a very wide variety of goals, ranging from getting up in the morning or getting a glass of water to finishing that book you're reading

9. Strictly speaking, the adjustment is not in the value associated with a particular CS but rather in the identity of the CS that is involved in the processing. A change in the situation is reflected in newly activated contextual representations in CS, which combine with the original CS. This more composite representation can have different value associations than the more basic CS originally involved in the processing.

or becoming rich. We will give a brief introduction to the MCF conception of goals here and then develop the ideas in some detail in Chapter 4.

In the framework, a goal is a representation in CS, not fundamentally different from other CS representations. What makes it a goal is its inclusion of representations of a desired but unrealized state and the intention to bring that state about. To say that the state is desired is to say that it is valued; i.e. the !pos! representation in AfS is associated with it. We will characterize the intention to achieve as *SEEK*.[10] It is, again, simply a CS representation. Goals then have the form *SEEK* (STATE$_x$), where 'STATE' is necessarily used in a very broad sense, including for example states of carrying out activities.

Activation of a goal representation leads, through normal spreading activation, to activation of any representations associated with its components – seeking or the state. These will include means of achievement of the goal and possible problems with achieving it or seeking to. This spreading activation is, as always, both within CS and across interfaces to other modules.

A goal of getting a drink would look something like the following: *SEEK* (DRINK WATER).[11] Its activation spreads to CS representations related to general seeking and of drinking water and especially to any representations that have become associated through past processing with the goal representation as a whole, i.e. with the goal of getting a drink. Prominent among the latter are representations of the actions involved in getting a drink and of locations where water is to be found. Representations of the person's current situation (sitting in a restaurant, driving a car, lost in the desert…) will also be active and will therefore interact with the active representations of possible actions. Under normal circumstances the end result of all this activity will be activation of representations in motor structures that will achieve the goal.

8. Self

Self is a notoriously confusing, if not confused concept. Among those who study the subject there appears to be something approaching a consensus that there is no one thing in the mind or brain that can be called the self. Nevertheless, self, like affect and goals, is not a concept that can be conveniently set aside in explanations of bilingual processing. Authors typically speak of several types of selves,

10. We use this special notation to distinguish this representation from SEEK, which is simply the meaning of the word 'seek' (cf. Chapter 4).

11. It is not difficult to imagine other, possibly better ways to formally characterize the goal, but we will leave this level of detail to those who are better qualified to deal with it.

with inevitable variation among them regarding what those types are. In MCF we hypothesize three types, corresponding reasonably well to some proposals in the neuroscience literature, notably that of Damasio (2010).

It is necessary to distinguish, first, between self as CS representation(s) and self as AfS representation(s), with intimate interactions between them. To begin with the latter, the *affective self* is a relatively primitive form of self, associated with the lower and older portions of the brain, but extending into medial and orbital regions of the cortex (Fuster, 2015). It is found to some degree in any organism that possesses a brain and a body, as its function is to bring some coherence to the workings of the body and its relations with the environment. In MCF, this translates to a composite representation consisting of various affective representations corresponding to basic drives, urges, motivations, emotions, and so on.

The way this composite AfS representation forms early in life, and adjusts to later circumstances, determines basic features of an individual's character. If a !fear! representation, for example, is frequently and strongly activated, it will acquire a high RLA and can then come to dominate the affective self, being strongly activated during almost any activity of the latter. The degree to which this occurs is the degree to which the individual can be characterized as an anxious, fearful person.

CS selves, being part of CS, are associated with higher, newer portions of the brain, i.e. parts of the cerebral cortex, particularly the more lateral portions. It is necessary to distinguish two types of CS self – a *goal-based* 'actor' *self* and a *meta-self* constituting the person's knowledge and beliefs about him/herself, with strong interactions between them. The goal-based self, a complex semi-structured collection of goals, will play a particularly important role in the discussion of internal context. As with the affective self, it can be dominated, momentarily or in a more lasting manner, by individual goals, which then constitute a significant aspect of the person's behavior and character.

Dominance of this sort can be a product of influences from AfS. Strong, chronic activity of !fear!, for example, is likely to lead to the creation and chronic activation of goals of avoiding fearful situations and of dealing with them in a manner that will minimize the fear. This example has significant implications for bilingualism, in the form of language anxiety. It also brings out the intimate connections between the goal-based self and the AfS self, connections that might well be seen in terms of schemas. When standard patterns of affective and conceptual (as well as motor) activity develop for fear-provoking situations, we have a schema. More broadly, patterns of this sort probably typify activity in affective and conceptual selves and define what we normally think of as the self. Thus we might say that 'self', as it is commonly understood, is a schema.

Importantly, each self – goal-based, affective, and meta-self – is a representation, not fundamentally different from any other representations. These selves are not entirely fixed. Different situations, in particular, can yield different if greatly overlapping selves. Bilingualism provides an important example. Bilinguals often have a sense (a correct one, we will suggest) that they have somewhat different selves when speaking different languages. This is a natural consequence of the framework, as we will show in Chapter 4.

We will develop these points in some detail below, beginning with a general description of the selves in Chapter 4. Chapter 8 will consider the role of selves in cognitive control and bilingual language control, emphasizing the goal-based self, and Chapters 9, 10, and 11 will include further applications of these ideas to bilingual processing.

9. The definition of context in the MCF

We can now finally turn to a more precise definition of how the notion context is expressed in terms of the MCF. We define the internal context of linguistic processing as all the activity in the system that influences linguistic processing without being part of it. Given the nature of language (see above and Chapter 1), the term 'linguistic processing' is necessarily somewhat vague. In its narrowest sense, it refers specifically to processing within the strictly linguistic modules, PS and SS. In its broadest sense it includes virtually everything that goes on in the mind during language comprehension and production. We will adopt the narrow definition, treating 'linguistic processing' as 'core linguistic processing', i.e. as all activity in the strictly linguistic modules, PS and SS. The internal context of linguistic processing is then made up of all *other* activity that influences this processing.

The importance of conceptual structures as internal context should be emphasized. In production, it is here that the content of a linguistic utterance is established. In comprehension, it is here that the perceived utterances are ultimately given meaning. Major elements of the internal context – goals and two self representations – are located here and exert powerful influences on processing in the linguistic modules. Contextual activity in CS thus has a direct and crucial influence on linguistic processing. The influence of other contextual elements, notably affective context, is primarily by way of CS. Thus CS will necessarily have a central place in the discussion of internal context throughout this book.

10. MCF architecture summarized

In conclusion, the MCF has a modular architecture. Its organization is based on a particular integration of current thinking within various relevant research fields that belong to the wider family known as cognitive science. In its current guise, this consists of five perceptual systems reflecting the five senses although one of them is not a traditional one but one that is now generally accepted in neuroscience, namely the somatosensory system. This group of highly interactive and richly interconnected perceptual systems together form the portal through which the outside world is interpreted and which forms the basis for further processing by other modular systems which in turn supplies the inner, interpreted world of the individual. The number of modules is not fixed. There may be reason to increase or reduce the number of perceptual systems for example and that is, as elsewhere, no problem in principle for the architecture of the framework. In this respect as in others, it is certainly flexible.

The modules that provide further processing of the sensory input are the *conceptual* system, the *affective* system, the *motor* system and, in addition, specific to human beings, the two linguistic systems that handle respectively *phonology* and *syntax*, which we also refer to as the core language system. There might be additional post-perceptual modules required but at the moment we have settled on these five. The fixed character of the framework resides in the way modules are structured and operate internally as a combination of processor and store and externally in their relationships with other systems, i.e., via a network of interfaces. The architecture also promotes a particular view of how conscious thought processes should be understood, without, of course, any claim that it fully explains consciousness itself.

The processor and store of a given module constitute the basic design that all modular cognitive systems have. Stores are the repositories of structures (also referred to as representations) that are composed according to principles unique to the module in question. They are activated in response to each other, to their processor, and to interfaces that connect the module in question with other modules. Activated structures effectively compete with one another by rising from their current resting levels as the processor attempts to build appropriate combinations in response to external input. This state of activation is called working memory.

The overall picture is of different combinations of modules collaborating to accomplish some task. Each participating module provides representations that are associated with representations in other modules: The sum total of activated representations at any given moment is in the form of networks called representational schemas of associated structures. This is perhaps best illustrated by what happens when someone speaks: The acoustic input caused by the utterance triggers associated auditory structures in the listener; a parallel activation of associated auditory, phonological, syntactic and conceptual structures in their respective modules takes place resulting in the virtually immediate experience of the meaning of the utterance in the listener's mind. The fact that a process of competition has taken place within each module in order to find the best overall fit between all representations on offer is of course something the details of which the listener can have no awareness.

In reality the mind is constantly active and in flux. Structures in any module are only more or less active. In other words, 'resting' is a relative term. The fixed modular architecture in other words still has a dynamic character. The more a structure is activated, the more established in terms of its RLA it becomes and consequently the better able it is to compete with rival candidates in any given act of processing. This activation can come, perhaps most notably, from the affective system, interacting with varying situational contexts.

To summarize our concept of internal context, at an appropriate level of abstraction, the context of processing consists of all activity in the system that influences that processing without being directly part of it. In the case of *linguistic* processing, activity in SS and PS is inherently linguistic and therefore is not context. Activity in perceptual, affective, motor, and conceptual modules, to the extent that it impacts processing in SS and PS, is part of the context. The contextual role of CS must be emphasized, as it is the crossroads of linguistic and non-linguistic processing and so has the most direct influence on linguistic processing.

CHAPTER 3

Outside in

External sources of internal context

1. Overview

We turn now to the various factors that make up what we have called internal context. To reiterate what was discussed in the second chapter, this does not cover all of what occupies the mental space of the language user: it excludes syntactic and phonological (i.e. 'linguistic') processing but includes anything else in the mind which impacts on how language, and in this case the language of bilinguals, is shaped during online processing.

Here we focus on that part of the internal context which although occupying mental space, originates primarily or completely in sources that are external to the language user, in the 'outside world,' as it were. In the next chapter, we will turn to those factors that are *inherently* internal. External sources will be familiar territory for any student of text, discourse, pragmatic usage in general and, of course, sociolinguistics whether or not they are concerned with language processing. Here we are, of course, indeed interested in processing and not only processing activity but also in the mental representations themselves that are processed and which constitute the recreated mental, i.e., 'internal' world of the language user.

The external context for any kind of language processing may be referred to using familiar terms like *situational context* or *discourse context*. In fact, discourse context could also be thought of as a special kind of situational context, something that forms a subset of the total situational context. Take the different meanings of the word 'branch' for example. When conducting some financial transaction in a bank, for instance, the situational context will raise the activation levels of those concepts that are related to the particular location of the bank, of particular *autobiographical* associations with any aspect of this particular bank and of concepts related to banks in general and of concepts without any special autobiographical association which are also related to banking. This will, then, render the meaning of the ambiguous word 'branch' as part of a tree less predictable than branch referring to the bank itself. In MCF terms, this means the current activation levels of the two conceptual structures in question will be adjusted. The levels of those CS that are associated with the organization of banks will be raised above that of the

CS associated with trees. Without any other disambiguating context, this will lead listeners to use the second meaning of 'branch' to interpret the word rather than the first one.[1] Again, situational context is processed by the mind and converted into internal context with the conceptual system playing the major role. Figure 3.1 displays the scope and connections involved in the processing of external sources.

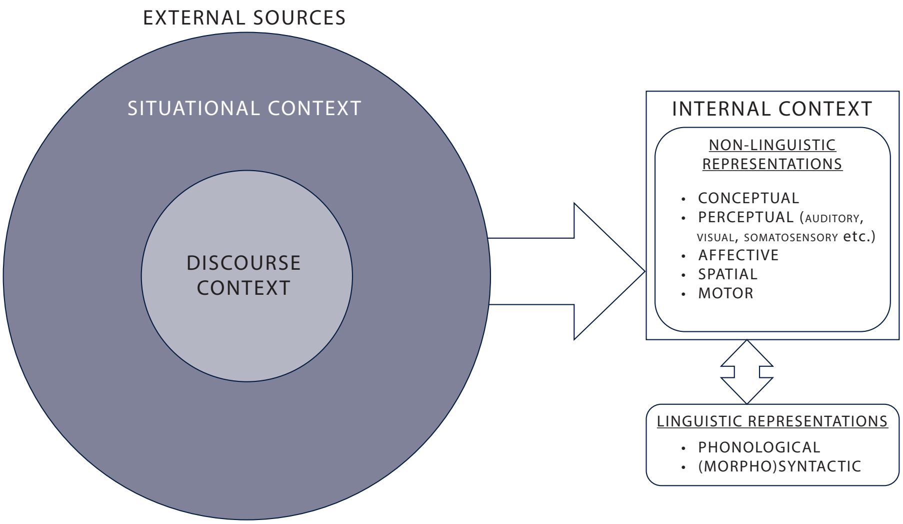

Figure 3.1 External and internal context

We will now begin this chapter with some general concepts that will be relevant to the discussion and a brief consideration of some alternative approaches that have potential relevance to the processing of context. Much in this chapter is relevant to both monolingual and bilingual processing.

1. It should be noted in passing here that the variable use of the terms 'discourse' and 'pragmatics' sometimes gives cause for confusion. We will try to avoid this by being specific about both terms. 'Pragmatic' is best understood in relation to 'semantic', the latter term, in linguistics, referring to the core linguistic meaning out of context and 'pragmatic' referring to meaning that is depending on context for its interpretation. Both types of meaning are created in the representational code of the conceptual system although inevitably pragmatic meaning will be represented by a more complex conceptual structure which, together with the nature of the evidence required for developing pragmatic knowledge, will help towards explaining the extra challenges it provides for language learners.

2. Context in the MCF

In Chapter 2 we were able to arrive at a definition of internal context from an MCF perspective as all the activity in the system that influences linguistic processing without being part of it. Situational context seen from an external sociolinguistic perspective has been the topic of a vast amount of research. It is, in the widest possible sense of context at least, the main object of sociolinguistic study, that is including general cultural norms and expectations as well as the particular situations in which language users find themselves. In this book where the focus is psychological rather than sociological, what we refer to as situational context, following the MCF definition of internal context, consists of the totality of a language user's internal representations of any given situation. This interpretation of context is similar to those approaches that refer to 'cognitive context' except this is more applicable when specifically discussing discourse context, a topic to which we will return later on in the chapter (cf. Sperber & Wilson, 1995; van Dijk, 1977, 2014).

3. Context as a continually changing phenomenon

Situations and hence the internal context that is relevant to a given act of interpretation or indeed production are in constant flux. This is an important point that is also central to the dynamical systems approach. It is important also to keep in mind that, as external circumstances change, even though ready-made schemas will be available to assist processing, the representations that an individual uses to interpret situational context on a given occasion are being continually 'updated'. A new situation that is similar to a situation recently encountered will not necessarily be processed in an identical manner: the interpreted (internal) world of an individual will also be changing as a result of new experiences and the resultant new knowledge may impact on the way new but similar situational contexts get processed the next time round.

For the most part individuals will have their ready-made schemas as a basis for processing any current situation (see discussion of schemas in Chapter 2 and below). In other words, even though the current, new external situation will be processed online by an individual and interpreted in the form of internal representations relevant for that particular moment, part of that interpretative process includes the deployment of a wealth of internal representations and connections many of which have been created already as a result of earlier similar 'situational' experiences. This means that any current situation will most likely be processed using one or other of the already constructed schemas in the individual's repertoire.

4. The central role of the conceptual system

As indicated above, in an MCF perspective, the processing of situational context crucially involves conceptual (CS) representations. This will be a continuing theme throughout this book and more will be said elsewhere about its composition and function. Perceptual representations of all types are clearly important as well since they form the basis of how the external world is initially processed. In addition, affective representations are also very important as they are implicated in how various aspects of the situation are appraised and in an individual's emotional responses to them.

Conceptual representations can be seen as the hub of a representational network that includes all kinds of co-indexed representations including those specifically linguistic ones. These modular networks are what we have called representational *schemas*[2] (or 'schemata') with representations in the conceptual store acting as hubs. Each 'partner' in a schema (see Figure 3.2) is a particular module's store (shown in each case as a box in the figures) that contributes given structures to the whole. To be absolutely clear, any given schema is not simply a network of participating *stores* but a network of participating *representations* i.e. those associated representations within the stores. This means that the connecting interfaces shown in (the simplified) Figure 3.2 actually link specific representations and only by association the module store to which they belong (see Figure 3.3). The linguistic nodes in a schema, i.e. the contribution of the *phonological* and *syntactic* partner stores, provide the linguistic structures to be coactivated: The conceptual partner provides the conceptual representations (CS) to be coactivated together with those linguistic representations (PS and SS). Moreover, the CS in a schema forming a node will include much more than the meaning structures that are associated with the linguistic nodes. The CS associated with other representational nodes in the network (visual, auditory, somatosensory, motor representations for example) will also be coactivated. In other words, participating conceptual structures in a schema for the word 'piano' will also include, amongst other structures, the CS associated with the relevant visual and auditory representations (VS and AS) for instance: These will also undergo some level of coactivation. Moreover, in the case of bilinguals, there will be coactivation of different types of PS-SS-CS chain appropriate for the processing of different languages with the currently relevant language determining which combination gets the highest level of coactivation.

2. Note this is an updated version of 'schema' in this framework referring to complex representations that associate structures in different modules, rather than the module-internal definition that was used in Sharwood Smith and Truscott (2014b, pp. 87, 140).

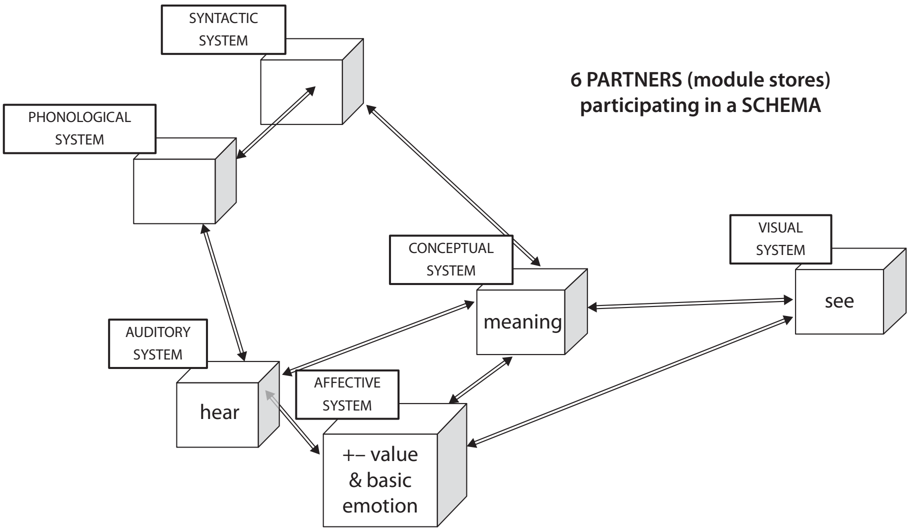

Figure 3.2 Schema partners

The pragmatic processing of the earlier 'branch' example provides a relatively simple example of a schema which does involve linguistically relevant meaning. The external visual scene associated with (financial) banks will be represented internally as rich, i.e. complex visual structure (VS). This will be the contribution to the bank schema of the participating visual partner module. We now think that the addition of a separate *spatial* module is necessary (for the sake of simplicity, this module is not shown in the figures and was not included in previous versions of the framework). This addition to the framework is justified partly on neurological grounds. This means that *spatial* structures (SpS) will then be involved in the processing of this bank scene as well. Note, however, that, as our language user is present in a bank, some visual and spatial structures may also be coactivated as a response to the external environment that are *not* part of the particular schema we are talking about, i.e. they will not be 'relevant'. The clothes of the customers for example will certainly be processed by the individual concerned but they are not a necessary part of the bank schema per se and so will not play a role in the coactivation of the currently appropriate CS of 'branch'. However, in situations where the clothes that are worn by people working at an institution – a bank in this case – specifically mark them out as bank employees, then the visual processing of these clothes will naturally become an integral part of the bank schema.

Finally, the central role of the conceptual system as a hub in schema building and schema processing in general should not alter its status as one other module amongst many. There is no hierarchy of modules in the current framework with the conceptual module acting as some sort of superior supervisory system. Rather,

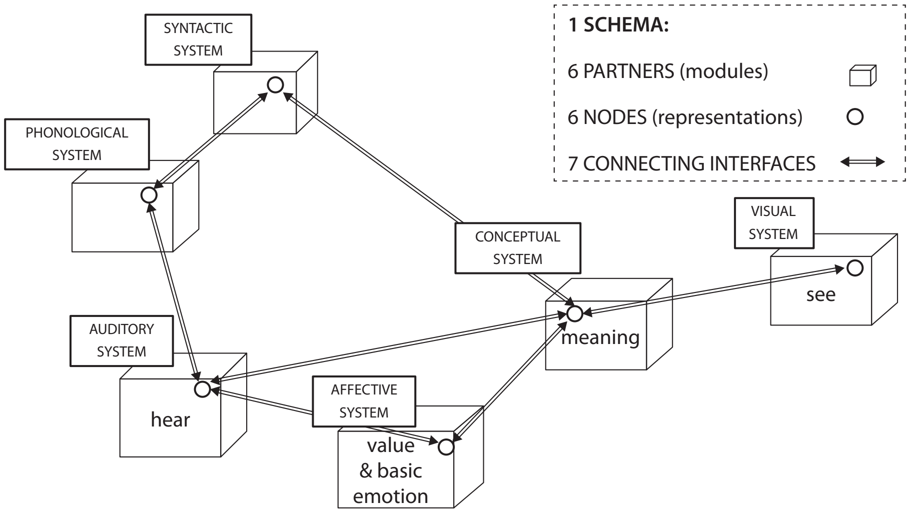

Figure 3.3 Schema nodes

all modules are equal because the modular system as a whole is *heterarchical* (Bruni & Giorgi, 2015; de Mey, 1977; McCulloch, 1945, 1988; Sharwood Smith & Truscott 2014b, p. 21). In other words, the balance of power shifts around depending on the circumstances: this allows the online construction of maximally flexible responses to any situation, internal or external. Within each module there will certainly be hierarchical processes at work but taken as a whole the system has no 'boss'. Only when given highly activated conceptual representations participate in the broad synchronization that is global working memory (GWM), connecting them to conscious experience, and are thereby involved in reflection and planning activity do we get anything that looks vaguely like a single 'command-and-control' center. However, any representation that currently has that status can have strong influences throughout the system *only as long as it maintains that status*. Normally it will not maintain the status for long, and it is the internal contextual factors that determine which representation has it at any given moment. In other words, representations that participate in the above manner in what is sometimes called conscious control can be very influential: At the same time conscious control is a fleeting phenomenon and the way it shapes behavior is still strongly affected by the (subconscious) internal context. It might indeed appear, from what we have discussed thus far, that processing might easily become chaotic without some kind of supervisory system. There already exist models that assume such a supervisory system (for example Dijkstra & van Heuven, 1998, 2002; Green, 1986, 1998). Several approaches proposed in the bilingual processing literature will be included in Chapter 5 and the MCF solution to the issue of control will take center stage in Chapters 6, 7 and 8.

5. Schemas

5.1 Multiple activation of schemas

Although schemas that underlie our instinctive behavior are, we assume, the result of evolution and are supplied in advance as part of our biological inheritance to optimize our chances of survival, most will be constructed and adapted over the lifetime as part of our ongoing experience of what we have called outside-in context (see related discussion in Geary, 2004; Thornton, 2003). They make it possible for us to cope with the enormous density, variability and often chaotic character of this ongoing experience.

During the current processing of a situation, many individual representations will be activated and not all of them will have a role to play in a given schema. It is also the case that there will typically be multiple schemas activated at the same time although at any given moment one may dominate the others especially when some conscious response to a situation is involved. For example, the clothes of the bank's customers in the bank schema described above were deemed irrelevant. However, they may well be relevant to another schema related to this situation, for example a personal attire schema triggered by the individual's noticing an attractive item of clothing worn by a bank customer that s/he would like to go out and buy. We must, in other words, assume that at any given moment there may be many activated schemas and/or rapid switching *between* schemas as suddenly one gets a boost over the other(s): This will help the individual to manage the highly dynamic and variable character of ongoing experience. Changes in the situational context will cause a currently dominant schema to give way to another one, based to a large extent on the relative value and hence activation levels of the representations that make up the schemas (for an application of this idea to code-switching, see Sharwood Smith, 2019b; Truscott & Sharwood Smith, 2017; and later discussions in this book).

In sum, it cannot be underestimated how complex the representations to be included in just one typical schema can be: This goes, indeed, for the level of complexity in each individual partner's contributions to the schema as a whole. Then when you also consider all the other schemas in a given situation that will be activated in the course of very short periods of time responding to a constantly changing environment and to switches to different attentional targets, it becomes extremely impressive what a mind is capable of, even allowing for the use of these schemas to reduce processing complexity.

5.2 Schemas as cognitive templates

Let us consider for a moment the resources available to the brain that supports the mind. The typical brain has about 86 billion neurons. The more important figure, though, is the number of connections among them (synapses), which appears to be in the hundreds of trillions. In this context, it is no surprise that the amount of information that an individual's memory, i.e. the combined representations currently available in all the different stores, can hold is vast. The resources that an individual's processing activities require just have to be vast in order to be able to keep step with a continually changing external environment and to activate, where appropriate, the linguistic structures needed to interpret and produce utterances in the situation of the moment. The simple example above of ambiguous 'branch' should already give an idea of the formidable tasks the brain is able to accomplish, often with ease and, more often than not, below the level of conscious awareness. As just suggested, the development and use of representational schemas are a way of handling this complexity. They are in this respect similar in function to the much smaller templates – linguistic 'constructions' that play such an important role in approaches that adopt some version of construction grammar: The current architecture, of course, interprets all such mental templates within a modular architecture not generally shared by constructionists and does not accord them quite the same role in accounts of development (see for example Goldberg, 1995; Tomasello 2003; also Jackendoff, 1996). In either type of approach, however, these cognitive templates, whatever their size and composition, can be seen as the mind's coping strategies in the face of the taxing processing demands imposed by ongoing experience.

The dynamic nature of mental life, the focus of approaches that are based on dynamical systems theory (DST), presents a similar picture but, again, in the MCF, the form that mental processing takes is constrained by the principle of modularity, including the modularity of the language faculty (see Elman, 1995, for a useful description of the potential relevance of DST for linguistics and van Geert, 2008, with particular reference to L2 acquisition). The underlying implication here is that much of the work on embodied cognition, construction grammars, cognitive linguistics and DST will and already does provide valuable insights into the nature of language cognition. A strength of the MCF, we feel, is that many of the various insights achieved by one or other of these approaches separately and sometimes together are integrated within a single approach to cognition and in a way perhaps not often associated with a more constrained modular approach. It has already been applied to a variety of different aspects of language and therefore merits serious consideration as a viable alternative.

5.3 Schemas and modularity

In the current approach, schemas are composed and are deployed through a collaboration between the stores of local systems (the modules): Each partner store contributes representations to the whole by coactivating them but still without requiring that the information be merged into a common code. When talking about 'schemas', we are always talking about associative networks of representations written in various *different* codes. The visual representation of a bank when activated in a bank situation coactivates other, coindexed representations in other modules and in this way the bank schema as a whole is activated. No common schema code is necessary for schemas to do their job any more than different systems in the body need to be run with identical pathways, cortical locations and neural firing patterns for the body to respond in a coordinated way to complex situations (see discussion in Sharwood Smith, 2017b, p. 12). Each type of representation in the schema is encoded differently and is therefore distinct and incompatible with representations supplied by other partner modules. These fixed patterns of coactivation that can be triggered in the form of schemas permit an immediate coordinated response to particular types of situations.

5.4 Schema updating

Given the constant change in the environment it is not surprising that the individual's response to external stimulation is dynamical in character and that cognitive templates of various kinds are used to handle this complexity. Moreover, given the mercurial nature of the external environment which never stays the same, each situation is likely to require additions and changes, i.e. the construction of new representations. Schemas may need updating as a result of some novel experience. There may even be a need to create additional schemas. The partly novel situation, as it is perceived by the person, constitutes input, which in accordance with APT results in new representations, constituting relatively novel combinations of existing representations. An existing schema will provide a framework within which new information can be placed. The revised 'updated' framework might then prove over a period of time to be able to function as a replacement or as an extra schema.

5.5 Schemas in bilingual processing

The need for updating schemas and developing new schemas is particularly obvious when considering bilingual and bicultural[3] situations. Grosjean's Complementarity Principle is very relevant in this regard:

> Bilinguals usually acquire and use their languages for different purposes, in different domains of life, with different people. Different aspects of life normally require different languages. Grosjean (2010, p. 29)

This implies that contextual representations strongly associated with linguistic (phonological and syntactic) representations of one language will be different from those strongly associated with linguistic representations of the other language. At the same time certain types of situation will come to be associated with schemas that include linguistic representations of one language and other situations will be associated with schemas that come to include linguistic representations of the other language. This will manifest itself in bilinguals preferring to operate in one language rather than another in given types of situations without necessarily being completely unable to operate in the dispreferred language. For example, heritage language speakers who speak their parents' language at home and another language at school may prefer to speak about school topics and school situations in the language most associated with them without being unable to talk about them in the home language as well. The schema that includes the most firmly established linguistic representations from the school language, that is includes the matching phonological and syntactic representations associated with that language, will tend to be chosen for discussing homework, teachers, school friends and the like: Here we are assuming that there are, for the bilinguals in question, no gross discrepancies in proficiency that would play a role in the selection.

In processing terms, a language-specific schema appropriate to a given context like 'home' or 'school' will not necessarily be the one that has higher resting levels but in a given situational context will have an extra boost to its resting levels because it will be associated with structures that are coactivated when the individual finds themselves in the situation in question, at home or at school, the boost coming especially from the *affect* associated with those situations. In other words, the experience of being at home has as its consequence the strong activation of a range of associated representations associated with this frequently encountered home situation. Any conceptual, visual, or auditory representations (CS, VS or AS) included in these representations that happen to be directly linked with particular PS and SS will boost the activation levels of those associated linguistic structures as well. In this

3. As always, we also mean '*multi*lingual' and '*multi*cultural' when using these two terms.

way chains of representations that were created to operate the home language will be coactivated along with everything else associated with home. That does not preclude the bilingual using the normally dispreferred school language at home but it will need the activation of new contextual features to force a change in the language being used like, for example, those associated with the arrival of a visitor who does not speak the home language. The entry into the home environment of monolingual friends belonging to a young bilingual's peer group provides a classic example. In other words, factors in the external context (as processed by the individual) trigger changes in the activation levels of relevant representations and these then determine a change in which of the bilingual's languages will be the dominant one. No extra decision-making system is necessary to select the appropriate schemas.

Although the affective system plays a crucial role in boosting the activation levels of one or other schema, it should be emphasized that it is the conceptual system that plays the central role. It is in the conceptual system that the given situational context becomes meaningful: Perceptual processing of the current ambient environment needs the appropriate conceptual associations to be triggered to establish the identification of 'home' or 'school'. It is also in the conceptual system that *language* identification is established permitting, for example, the CS HOME to coactivate, along with CS LANGUAGE, the CS FRENCH (the home language) rather than the CS ENGLISH (the school language). This point has important implications for the way that context influences bilingual processing in general. Figures 3.4 and 3.5 which abstract away from particular types of situational context,

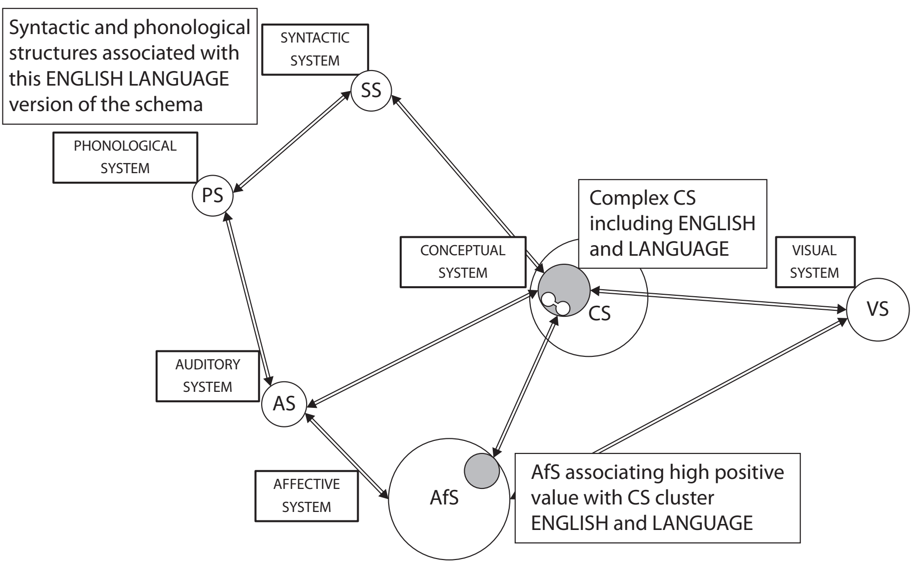

Figure 3.4 English version of a schema

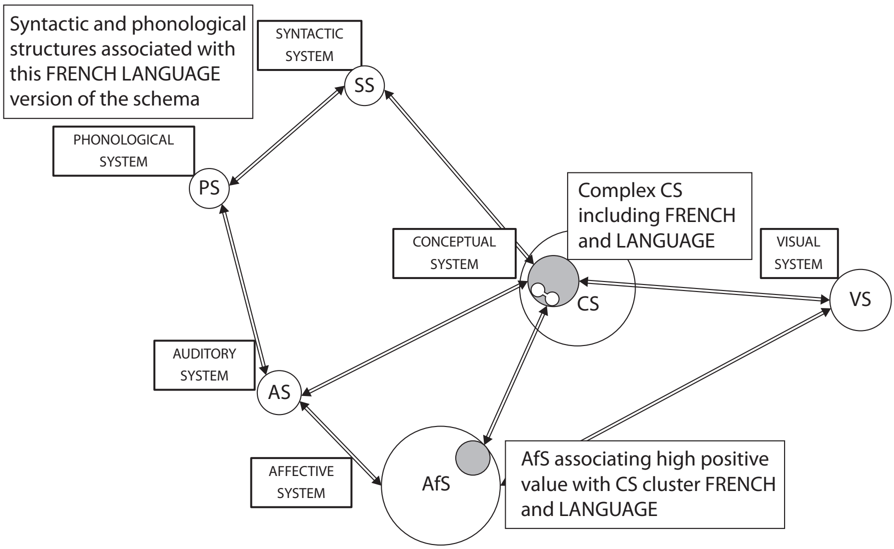

Figure 3.5 French version of a schema

work for any kind of code switching (see Truscott & Sharwood Smith, 2017). To properly describe which schema is being discussed, a figure like these would have to add more detail and particularly with reference to which conceptual representations are activated but also with regard to what types of perceptual structure are coactivated: The figures here only refer to visual processing. For example, in the case of the switch between the bank schema and the personal clothing schema, these two figures would also have to specify the conceptual structures associated with switching between these two alternatives. This goes for any situation that triggers a language switch including, say, those where heritage children might be talking to their parents about school or about home topics, or bilinguals switching from one language to another when, after talking formally, or in some stylistically neutral manner, they turn to some personal topic and a language more associated with that greater degree of intimacy.

5.6 Frame semantics and other possible relatives

Those familiar with Fillmore's pioneering work on 'frame semantics' may have already seen the resemblance between the schemas elaborated in this book and the cognitive and linguistic frames that he proposed (Fillmore, 1977, 2006). Although Fillmore like George Lakoff, another person who has developed the frame idea albeit in a different direction, did not espouse a language faculty approach to the mind, none the less the basic idea behind frames as presented by both of them fits very easily into our modular cognition processing framework. Fillmore developed his idea of lexical frames following on from his work on case frames. The idea was to show how the interpretation of a lexical item is affected by relating it to a wider conceptual frame (i.e., schema) in which a particular item contributes its meaning as part of the frame in general. Words and expressions like ‘savings account’, ‘exchange rate’, ‘in the red’ and a particular meaning of ‘branch’, all invoke a banking frame and this in turn guides our interpretation of any individual item that is part of it. Without these semantic frames, we are unable to achieve a proper understanding of these individual words and expressions. Extended to syntactic construction this became, for Fillmore, Lakoff and others, a key notion in the development of construction grammar (see for example Fillmore, Kay, & Sag, 2005; Goldberg, 1995; Lakoff, 1987; Langacker, 1991). The similarities between these approaches and ours illustrates the usefulness, to the development of the MCF, of research conducted with different perspectives on the nature of cognition.

There are also some resemblances, again at a very general level, between the present approach and that of Teun van Dijk who developed along with Kintsch a model of discourse processing which assumes a network model of memory based on the ideas of Norman and Shallice (Norman & Shallice, 1986; van Dijk & Kintsch, 1983; see also Cicourel, 2006; van Dijk, 2006). Like many psychologists van Dijk and Kintsch distinguish between two basic types of memory, episodic memory and semantic memory (Tulving, 1972, 2002; see also, e.g., Clayton, Salwiczek, & Dickinson, 2007; Dere, Kart-Teke, Huston, & De Souza Silva, 2006; Eichenbaum, 2003; Platel, Baron, Desgranges, Bernard, & Eustache, 2003). They talk about ‘situation models’ which they describe as the cognitive representation of the events, actions, persons, and in general the situation, a text is about (pp. 11–12) and about ‘textbases’ which are the semantic representations of the particular input discourse in question, in episodic memory (p. 11). Having no separate means of describing the processing of *linguistic* structure of discourse, as opposed to its *situational* structure, meant that it had all to be accounted for in essentially the same way as part of general cognition albeit with the two basic types of memory, episodic memory being involved in both textbases and situation models. They also discuss other work on ‘knowledge structures’ which they refer to, following previous work by others, variously as ‘frames’, ‘scripts’ or ‘schemata’ (Minsky, 1974; Rumelhart & Ortony, 1977; Schank & Abelson, 1977). Given the fact that they adopt a general model of cognitive processing which is different from ours, using notions like semantic and episodic memory in a different way to us and talking of a ‘central processor’ which does not figure in our framework, it is not possible to draw too many parallels between this framework and our own. There is a shared ambition to interpret context within a cognitive perspective but our approach is much more focused on establishing a modular model of the mind into which such disparate ideas can be coherently integrated.

Finally, mention should be made of Sperber and Wilson's (1986) Relevance Theory (RT). In this processing approach to researching utterance comprehension, Grice's Principle of Relevance (Grice, 1967) is converted into the Cognitive Theory of Relevance (Allott, 2013; Wilson & Sperber, 2004, pp. 625–626). Unlike Sperber and Wilson for whom it was central, Grice was not concerned with talking about relevance or any of his maxims from the point of view of a cognitive psychologist. Cognition in RT is characterized by a drive to maximize relevance: More specifically relevance is defined as a trade-off between cognitive effects and processing effort. Cognitive effect essentially means that the input utterance is making a worthwhile difference to the hearer's representation of the world, that is, as opposed to adding nothing new (Wilson & Sperber, p. 607).

Since RT is very much a psychological approach to input processing, it is important to locate it within a more general understanding of how the mind works. Allott (2013) observes that in the beginning a more or less Fodorian model was espoused whereby there were both modular and non-modular processes involved in utterance comprehension, the linguistic processes being carried out by a fast, automatic, informationally encapsulated system and pragmatic, inferential processes being non-modular and handled by the central processor. From the point of view of the current framework there is no non-modular processing so the work done by pragmatic inferencing is carried out in the conceptual system which is also modular.[4] More recently, Sperber and Wilson have espoused massive modularity where different conceptual functions such as utterance interpretation, logical deduction, theory of mind are separated out as assigned to different putative modules (Sperber, 2005; Sperber & Wilson, 2002). There is no reason why, in the current framework a module might not eventually be split up in a similar manner especially if there is independent support for this from psychological and neuroscientific research and we have occasionally made suggestions to this effect when such supporting evidence has come to light although we find that it is prudent to start with a relatively small number of modules in the meantime. Given this more parsimonious approach it is still possible to reinterpret these conceptual functions within the MCF as belonging to the conceptual system with the estimation of costs and benefits that play an important role in Relevance Theory handled as associations across the conceptual-affective interface.

4. We have occasionally used the term 'extramodular' solely to distinguish representations and processes *within* what is often referred to as 'the' language module (in our terms actually itself composed of *two* modules) and representations and processes *outside*, i.e. in other modules that handle other types of representation such as the perceptual modules and the conceptual module (Sharwood Smith & Truscott, 2014b, pp. 217, 335; Truscott, 2015a, pp. 169).

There are however still some important differences between RT as it is now, and the current approach, possibly as the result of a somewhat unconstrained espousal of massive modularity. For example, RT theorists make a distinction between 'representational' meanings and 'procedural' meanings. Utterance processing has a *linguistic decoding* phase: this yields what might be called the core meanings of the words and constructions, the 'representations'. However, words can also supply so-called 'procedural meaning': this has the effect of imposing constraints on how the utterance is processed by providing information on how the representation supplied in the linguistic decoding phases should be manipulated. Discourse connectives are a case in point. Allott (2013) illustrates this by showing how a follow-on sentence with 'so' will constrain interpretation of what has gone before in a different way to 'after all' as in:

(1) Her cat is antisocial. So/After all no one picks him up and pets him.
(Allott, 2013)

There is no doubt that approaches such as RT and Kintsch and van Dijk's have yielded, and will go on yielding many fascinating insights in to the complexities of utterance comprehension and what an elaborated theory of how the mind works will need to account for. However, in both cases, although cognition and psychological processing are taken seriously, the focus and the weight of contribution to our understanding is still on detailing the logical problems, the *what* to be accounted for in full utterance comprehension rather than any detail about just *how* the mind is actually doing it, in other words, still leaving relatively underspecified how these logical problems are resolved psychologically in line with current thinking in cognitive science. This might seem to be an overly critical evaluation. Nevertheless, at least from the current perspective and with the current focus on detailing a working model of mental storage and processing in general in line with contemporary thinking in cognitive science, it would appear that there are important issues that still need to be addressed in much more detail concerning the cognitive architecture to be associated with these approaches. This means more overall clarity and coherence in accounting for the nature of memory, of conscious and subconscious processing and of the growth of new representations in psychological terms and not just with reference to their abstract linguistic structure alone. In any case, we see no immediate need, in our architecture, for creating different kinds of meaning representation, i.e. different modules and different modes of meaning processing. We are also more specific about how explicit conscious processing is involved in both utterance comprehension and utterance production. This means that RT and perhaps some other approaches to discourse comprehension are in principle compatible but with different degrees of adaptation to the current framework carried out in a mutually beneficial way.

5.7 Communicative competence

No account of bilingual pragmatic and discourse acquisition would be complete without at least a brief mention of the pioneering work carried out in second language acquisition research circles by Kasper, Bardovi-Harlig and others although the focus has been on how L2 development proceeds rather than on the nature of pragmatic processing per se (cf. Bardovi-Harlig, 1999; Bialystok, 1990, 1993; Kasper & Schmidt, 1996). The motivation for much of this work was, in part, a concern that L2 research was too concentrated on grammar, and especially syntax. Also applied concerns may have had some influence on this trend given the contemporary emphasis on communicative ability as opposed to grammatical accuracy as manifested in the 'communicative approach' to language teaching and the theoretical discussion around the nature of 'communicative competence' (Canale & Swain, 1980; Faerch & Kasper, 1983). It can be argued the MCF enables this research tradition to be placed into a wider context in which L2 development is integrated into accounts of on-line processing and all other kinds of language development.

6. Pragmatic processing

6.1 Context and language processing

Up to now, we have been dealing for the most part with situational context in general, a portion of which, at any given moment, will have nothing to do specifically with language, i.e. not obviously or necessarily requiring choices regarding which linguistic structures to use and which language (in the case of bilinguals). Those aspects of situational context that do have direct relevance for language use fall under the general rubric of *pragmatics. Discourse* studies, *text linguistics*, *pragmalinguistics* and *sociopragmatics* all relate to this general category of pragmatics albeit reflecting different areas of focus.

Pragmatics is crucially tied up with the communicative goals of the participants in an exchange, and whatever else is involved in the schemas that are activated during pragmatic processes, goals will always be a part of them (see Chapter 4 for discussion of goals). Individual utterances involved in an exchange can vary in length from single word utterances, short phrases, single complete sentences or stretches of more than one sentence. In the spoken mode, with two or more active participants, discourse analysis is employed to analyze conversational interactions. In the written mode with only one active participant and other participants not physically present and able to respond directly, 'exchange' is not really the right term but in any case analysis focuses on the structure and lexical choices in a continuous text which often extends to many sentences. Linguistic analysis will focus on what in the language (markers of cohesion) signals that a stretch of continuous text can be regarded as a unit and on what makes it coherent which has to do with use of language related to the information content. The distinctions between discourse and text, coherence and cohesion vary somewhat (Brown & Yule, 1983; Halliday & Hasan, 1976; van Dijk, 1980). What interests us in this book are the wider processing aspects required to produce and understand discourse, spoken or written as interpreted within the MCF and, in this chapter, how they relate to the internal context that originates in the outside world: This must include knowledge of the pragmatics of the language(s) an individual has acquired to date and this pragmatic knowledge in turn entails any world knowledge that is required for discourse to be understood and produced as effectively as possible.

As was already illustrated with the early, quite simple example of the ambiguous word 'bank', pragmatic processing involves the activation of a representational schema: These typically involve many modules. One of them, the affective system, plays an important role in assigning value via affective structures (AfS). The participation of these AfS will have the effect of boosting the activation level of any associated CS in the schema and influencing in turn all other nodes in the schema including the linguistic ones, i.e. the phonological (PS) and syntactic (SS) nodes. Pragmatic processing involving more complicated linguistic constructions proceeds in essentially the same manner. In the case of bilingual pragmatic processing even more PS and SS will be involved in these large-scale schemas since the syntactic and phonological systems of both languages will be coactivated with varying levels of activation and in competition with one another. In this way, the affective contribution to the schema permits the relatively simple basic modular architecture of the MCF with a limited set of mechanisms to generate extremely complex dynamic processing events (Sharwood Smith, 2017c).

6.2 Bilingual pragmatics and status of concepts

6.2.1 *Linguistic relativity*

In our pursuit of the relationship between the external and internal context, there is a much debated question which asks if particular languages shape our way of thinking, classic examples being different ways in which a given language divides up the color spectrum and whether that completely shapes or at least influences to some degree the number of colors we see. Linguistic relativity became an issue in modern linguistics with the work of Sapir and Whorf giving us the *Sapir-Whorf hypothesis* which answers this question in the positive although both stronger and weaker versions of this idea are proposed (Sapir, 1949; Whorf, 1956). Categories of time have also been popular ways of conveying what linguistic relativity means.

Perhaps the best-known example is Whorf's controversial Hopi example where he claimed that speakers had a completely different concept of time since time was not reflected, he thought, in Hopi words and grammatical distinctions suggesting a strong version of the hypothesis (cf. Boroditsky, 2001).

Although few people seem to take the strong version of this hypothesis seriously, the weaker version where hard and fast distinctions are replaced by language-influenced biases and preferences deserves some consideration. In other words, how is it that speakers of different languages respond differently to tasks requiring decisions based on given conceptual categories like shape or texture? This suggests that their perception of certain aspects of external reality is biased depending on their language background. Moreover, developing bilinguals (language learners) appear to respond differently from their monolingual peers on such tasks suggesting that acquiring a new language can have an influence on such perceptual biases (see, for example, Cook, Bassetti, Kasai, Sasaki, & Takahashi, 2006).

As we have indicated earlier, our framework architecture can explain such biases in terms of conceptual representations (CS) and relative levels of activation. Having a language that distinguishes say three types of cold weather precipitation such as hail, sleet and snow means that its users will have three distinct concepts in the form of three CS associated with three sets of PS/SS that will be coactivated with relatively high frequency leading to high resting levels of activation. This will mean that three patterns of sensory input will be frequently activated and attended to. A language and culture that has only one word to cover these three types of precipitation will have a generic concept for precipitation which has a similarly high resting level of activation without in any way precluding the ability of speakers to distinguish one way or other between the types and indeed to express those distinctions using the available lexical resources in their language even though it is not their habit to do so.

6.2.2 *'Semantic' versus 'conceptual'?*

Semantic and conceptual processing in the MCF is accounted for as the domain of a single amodal conceptual system making the distinction between what is semantic and conceptual an issue for how that single conceptual system is organized. As suggested earlier, the semantics/pragmatics distinction is a potential source of confusion depending on the assumptions held about the precise definition of these two terms. Sometimes the distinction can be quite trivial on further analysis but there are also more fundamental issues involved which are about how exactly to explain how meaning is represented and processed in the mind/brain, a central issue for the MCF.

Pavlenko (1999) has criticized the debate around the nature of the bilingual lexicon for an unjustified conflation of semantic and conceptual levels of representation, the former level essentially referring to word meanings. Since, in the current framework, these two levels are both handled within the conceptual system, we might, at first blush, seem to be open to the same criticisms but Pavlenko's concerns are actually unproblematic for the MCF. As we have already explained, the distinction between *language-related* conceptual structure and conceptual structure in general can still be made but in terms of the nature of the associative links between conceptual features (CS) within the conceptual system as a whole: 'Semantics-only' associations represent the core, situational context-free meanings that are associated with given PS/SS chains. Where there is polysemy, as in 'branch' meaning either a part of a tree or, for example, a local office of a bank, *both* of the PS/SS/CS chains involved are activated simultaneously when the word 'bank' is heard. There is also an extended network of associated CS reaching beyond these smaller representational networks along with associated values (AfS) that are activated to determine which one of these two meanings is to dominate over the other in a given situational context. Moreover, there are also CS that do not have any direct associations with the core linguistic modules because the language user is unable to express these meanings without resorting to paraphrase: In other words, their language simply has no word for the concept in question. In this way, the framework provides the means for detailing the way in which concepts are formed in the first place and the role of language in that process. In addition, the relative resting levels of activation of various CS involved will make them more or less available in processing and clearly PS/SS/CS chains of association that are regularly activated during language production and association will have an impact on performance in given contexts.

Pavlenko points to supporting evidence from aphasia studies to justify a semantic/conceptual distinction (Caplan, 1992; Damasio & Damasio, 1993). However the significance of neuroscientific evidence, although a valuable source of implications for psychological architecture, is hard to evaluate. In this regard, Handjaras et al. (2016) examine the theory held by a number of people that there is no independent semantic (or conceptual) system in the brain at all but rather that semantic knowledge arises, in one particular account, from an integration of sensory systems (Warrington & Shallice, 1984). Barsalou, from a grounded cognition perspective, is a notable example of someone who has adopted this point of view (see for example Barsalou, Simmons, Barbey, & Wilson, 2003; Kiefer & Barsalou, 2013). Handjaras et al. in their discussion compare such approaches with the theory that there is indeed a separate and independent, domain-specific system encoding abstract semantic/conceptual knowledge (Caramazza & Mahon, 2003). Both theories have their own explanations for semantic-related brain deficits so this does not help in any way resolve the issue. Handjaras at al. themselves investigated the differential role of low-level sensory-based and high-level abstract features in semantic processing, combining a production task with fMRI looking at congenitally blind and sighted participants to determine the role of sensory modalities involved in the processing of higher level abstract conceptual features. Blind and sighted individuals were presented in different modalities with 40 nouns from different semantic categories (tools, vegetables, fruits, vehicles, etc.) and given a limited time in which to enumerate the features that describe the words selected. At the same time neural activity was tracked using fMRI. They looked at cortical activity on a small region-specific scale as well as activity over an extended area of the cortex. The best explanation of their findings, in their view, was the existence of two levels of semantic processing: (a) a sensory level involving small-scale modality-specific representations and (b) an abstract conceptual level resulting from the integration of information across a large extent of cortex in the form of large-scale unique, modality-independent, representations. That is what we could easily think of as a neural reflection of the operation of the conceptual system as instantiated in the MCF.

Finally Martínez-Manrique (2010) reviewing work by Vigliocco, Vinson and associates regarding the nature of semantic representation observes that effects such as linguistically restricted semantic deficits and language-specific effects on various verbal tasks could be a reflection of the workings of syntax rather than semantics, i.e. differences in syntactic input as well as interactions between syntax and rich conceptual structure, a conclusion that is completely compatible with MCF processing architecture (Martínez-Manrique, p. 75; Vigliocco & Vinson, 2007; Vinson, Vigliocco, Cappa, & Siri, 2003). In sum, the available neurological evidence seems to offer no clear support for either the adoption of a modular distinction between semantics and pragmatics or indeed a rejection of any abstract conceptual system.

7. Situational context in neuroscience theory and research

7.1 Locations and connections

When, in the development of the MCF, attempts are made to align as much as possible research on the mind and research on the brain, it has always been important to carefully respect the two separate levels of description involved. Nevertheless, interconnectivity is certainly one architectural feature that both levels share. In current discussions of cognitive functions within neuroscience there has been an increasing focus on the pathways that extend both within and across different parts of the brain (Friederici & Gierhan, 2012; Gierhan, 2013a, 2013b). Similarly, one dominant feature of the way language is instantiated within the MCF and first described in Truscott and Sharwood Smith (2004) has been the extensive reach of the network of connections across different modular systems involved when languages are being acquired, represented and processed online. This too has as much to do with the connections activated during collaboration between different modules as with the modules themselves and the connectivity within them.

Also, even the mental modules themselves, their dedicated processors and stores, are not faithful reflections of single brain locations but are instantiated neurally in more than one area of the brain. Moreover, the number of mental modules is not fixed and further development might justify an increase differentiating, for example, between different functions within the conceptual system and granting them modular status. Aside from any theory-internal reasons for expanding or limiting the number of such subsystems in this way, neuroscientific research will play an important part in such decisions.

However many modules there happen to be in the MCF, at both levels of description it is clear that both mental and neural connectivity are crucial to functional explanations. Explanations of connectivity also include accounts of processing *hubs*, concentrations of radiating connections. Hubs (in both brain and mind descriptions) are particularly important when it comes to explaining the processing of context because so many functional subsystems are implicated in text/utterance comprehension and production, both in the mind and the brain. Finally, another important point is that although, earlier on, there was the idea that language comprehension proceeded in two stages beginning with the sentence and then wider context, there seems now to be a general agreement that everything proceeds together, with the mind/brain recruiting every relevant system in parallel to build up an interpretation of the language input from the word go (Hagoort & van Berkum, 2007). This idea is completely compatible with MCF architecture and its current assumptions about mental processing.

In Chapter 5 we describe neural research on specific locations of the conceptual system in the brain, with obvious implications for understanding of situational context. Two things have to be said here about this research which is already showing great promise. Firstly, it is nonetheless in an early stage of development and secondly, brain-mind mapping really requires a serious contribution from the mind side, more than just common sense or basic psychological categories. In other words, there is a need for a comparatively detailed and coherent mental model. For example, van Dijk and Kintsch (1983) whose pioneering research was briefly used above have provided their 'situation model'; this is an account of how language users integrate the content of the text with their background knowledge as they read or listen to a stretch of language. It is also the main source used by Ferstl and others for studying the processing of text and discourse – inference and coherence building online – at the neural level of description (see Zwaan, 2016, for a survey of more recent situation models).

The architecture of the MCF which covers all types of cognitive processing can certainly provide its own situation and context models. However, as will already have become clear, it will involve, amongst other kinds of processing, *language-specific* processing. This is quite different from what the Van Dijk and Kintsch model assumes based as it is on the semantic/pragmatic principles of functional grammar (Dik, 1978). The MCF draws on Jackendoff's architecture of the language faculty which entails, for linguistic structure, the existence of two modular systems dealing respectively with phonological and morphosyntactic structure. These two linguistic systems serve both monolinguals and multilinguals alike and language-differentiation is a matter of different connections drawing on the same repertoire of structures but in different ways. These different connections within this core linguistic system of two modules will also have different patterns of interconnectivity with other non-linguistic modules so that, in a multilingual, the way each language is integrated into situational context processing as a whole will also not be the same.

Another important difference between the van Dijk and Kintsch model and the MCF as with many other comparable models will be the way memory is conceptualized both in the sense of different categories of memory like episodic memory and semantic memory as well as the basic distinction between working and long-term memory. This underlines the importance, in mind-brain mapping, of which psychological model along with which linguistic theory is to be used to associate cognitive functioning with particular patterns of brain activity.

7.2 Top down processing, bottom up processing and embodiment

The kind of ongoing integration of external input and what in this book we have called internal context naturally involve a great deal of continuous top-down processing in order to build up an adequate interpretation of a stretch of text. In order to provide a full interpretation of oral and written utterances, language users have to use a considerable amount of top-down processing using predictions based on their knowledge of the real world (already internalized context) and of their command of language being used. By the same token, speech and writing is produced on the assumption that listeners and readers will be able to engage the requisite top-down processing in order to supplement what they get bottom-up from the language input supplied by the speakers and writers.[5]

The creation of internal context using sensory input from the environment also raises the question of 'embodiment', the idea that cognition and sensory

5. The strategies that guide utterance production and especially interpretation are the special focus of Sperber and Wilson's (1995) Relevance Theory.

perception are intimately related. It may be useful to situate the MCF with regard to this relationship since it concerns the workings of the conceptual system which plays the role of a hub in context creation. In their review of embodiment and the neuroscience of semantics, Meteyard, Cuadrado, Bahrami, and Vigliocco (2012) divide semantic theories into four groups forming a continuum ranging from *unembodied* theories such as Levelt (1989) through *secondary embodiment* theories such as Mahon and Caramazza (2008), *weak embodiment* theories such as Barsalou (1999) and Pulvermüller (1999) and ending up with *strong embodiment* theories such as Zwaan and Ross (2004).

Strong embodiment presents semantics as so dependent on the motor and (sensory) perceptual systems, simulating direct experience, that it (semantics) essentially becomes the same as these things (Meteyard, Cuadrado, Bahrami, & Vigliocco, p. 793). In semantic theories that are 'weakly embodied', there is a partial dependence on motor and perceptual information whereby representations are involved at these two levels as well as the more abstract level of semantic representation. The MCF draws a clear distinction between the initial stage of sensory perception and the outcome of transduction whereby sensory stimuli are converted by the respective processors involved to create various kinds of perceptual representations (AS, VS etc.) as well as motor representations (MoS) in the motor system. This then would seem to designate the framework at first glance as either 'weakly embodied' or a case of 'secondary embodiment'. However, secondary embodiment is the more likely of the two since, here, the conceptual system is completely amodal: In other words, it does not include any sensory or motor information in any form whatsoever. Weakly embodied theories, according to the four-way classification would seem to suggest the presence of representations, in the conceptual system, of some sensory and motor representations. In MCF these would only be found in the perceptual or motor modules.

It is actually not clear from the description of this classification system what sensory and motor 'information' actually means. In the MCF, there is the amodal conceptual system on the one hand, and, on the other hand, there are the various perceptual and motor systems with which it (the conceptual system) is linked by interfaces. Any simulation of sensory and motor experience is perfectly possible but it arises out of a coactivation along the respective interfaces of conceptual representations and specific perceptual and motor representations in their separate modules. All of these mental modules may be associated with particular locations in the cortex and their interconnecting interfaces may be associated with pathways linking up both cortical and subcortical areas as well. We would have to conclude, then, that the MCF is at most embodied in the secondary sense.

7.3 Further topics for consideration

Some important areas in later chapters will also include a discussion of relevant research in neuroscience on *control, value, affect, goals*, and *self*. This will be in greater detail than in this section and with appropriate references. Here we will just touch on some of these topics by way of an introduction.

Among the topics associated with the notion of control are attention, synchronization, selective activation and inhibition. Activation and inhibition is a topic of particular interest to researchers in bilingual processing looking at various types of crosslinguistic influence in, for example code-switching. Switching control means activating one language at the expense of another competing language (or other languages in the case of the multilingual) and also reversing the situation so that the previously inhibited language can now become the dominant one. Control has been a topic for neuroscientific research as well involving the identification of control regions in the brain – these are primarily associated with prefrontal cortex (PFC) – as well as establishing how these regions exert control over processing in other areas.

Synchronization can be looked at in two ways, locally and more broadly. In the MCF it is a function of the processor within any module making coherent representations out of all the various currently active representations in its store. Broader synchronization occurs across modules again to achieve broader coherence. At the neural level there are possibilities of, for example, associating cognitive and neural levels by looking at gamma and theta oscillations but the question remains about how synchronization is brought about and what causes levels of activation, whether from a neural or cognitive point of view, to rise and fall. The natural place to look is not in the sensory perceptual system where high levels of activation are the norm but in the amodal systems. One is the conceptual system, where goals are formed and processed. The other is the affective system, which manages value and emotional content determining the relative importance of goals as exemplified, in multilinguals, in code switching behavior and language dominance in general (Truscott & Sharwood Smith, 2017; Sharwood Smith, 2017a, 2017c). We will go into more detail on all these issues in subsequent chapters.

8. Conclusion

We have used the idea of external things becoming internal, but some caution is required with this way of thinking about the phenomena. It should be clear that we are not suggesting that something outside the person is literally being taken in (see Sharwood Smith, 1993). The claim is that external factors are being represented in the individual's cognitive system. This, like perception and memory in general, is a constructive process. It depends on the individual's biases, knowledge, beliefs and affective profile. As descriptions of the external factors, the resulting representations might be distorted or even entirely wrong. We know in fact that people sometimes do form very wrong ideas about what is being said to them or about the person they are talking to or the situation in which they are interacting. This is true whether you have a mastery of only one language or two or many. What we are interested in – the internal context – is the way these things are perceived, regardless of the accuracy or appropriateness of the perceptions.

CHAPTER 4

Inherently internal context

1. Introduction

Internal context consists of activity that influences linguistic processing, including bilingual processing, without actually being part of it. In the previous chapter we considered the external sources, as they are realized in conceptual structures and beyond. In this chapter we turn to sources that are by their nature internal, in the sense that they are not representations of the external world: goals, value, affect, and self (selves, actually). Like the external factors, they operate mainly through activation of CS representations, which then influence activity in the linguistic modules and elsewhere.

The factors of inherently internal context can sometimes be found in discussions of bilingual processing, but often only implicitly, and never taken together in the sort of terms we are suggesting. The term 'goal' sometimes appears in the literature (see Green, 1998, for example), but deserves a more fundamental place in bilingual processing than it commonly receives. Goals are of great importance here, as they are for cognition and behavior in general; language use and the choice of which language to use are virtually always in the service of goals, whether the goal is to communicate information, to entertain, to bond, to express one's cultural identity, or whatever. Emotion is widely recognized as an important factor in bilingualism (e.g. Altarriba, 2013; Altarriba & Basnight-Brown, 2011; Dewaele, 2010; Dulay & Burt, 1977; Ivaz, Costa, & Duñabeitia, 2016; Kim & Starks, 2008; Krashen, 1985; Pavlenko, 2005b; Schumann, 1997; Sharwood Smith, 2014a; Sharwood Smith, 2017c; Wu & Thierry, 2012). Its central component, value, is not so widely recognized, at least not explicitly, but it is clear that what matters to the person, in good or bad ways, is of great importance for the way bilinguals use their different languages, and for language performance in general. The most complex of the elements of internal context, self, has been an important concern in bilingualism for some time (e.g. Dörnyei, 2009; Ervin, 1964; Grosjean, 1982, 2010; Hemmi, 2014; Mercer & Williams, 2014; Norton, 2013; Taylor, 2013), but exactly how it is to be understood, in itself and in the context of bilingualism, remains very much open to discussion. We will suggest here that there are three distinct selves. All these elements need to be understood in the context of the mind as a whole, including major phenomena like attention, effort, working memory, consciousness, and volition.

Understanding the factors of internal context and the way they fit into the cognitive system as a whole is a prerequisite for understanding bilingual processing. Our goal in this and the preceding chapter is to present a general picture of these factors and to introduce their role in bilingualism. In subsequent chapters we will show in more depth how this picture can contribute to an understanding of bilingual processing. The factors we will consider here are goals, value, emotion, and self, each of which is an important aspect of language behavior. Each deserves to be a standard topic in the bilingual processing literature and should certainly have an important place in any comprehensive approach such as MCF.

2. Goals

The first element of inherently internal context is the goal. In this section we will first review and extend the description of goals given in Chapter 2 and then consider how they form and how they function as internal context.

2.1 Goals in the MCF framework

In Chapter 2 we described goals as representations in conceptual structures. When we speak of goal representations we are not suggesting that the cognitive system (or our framework for understanding it) contains an entity called a goal. We define goals as ordinary CS representations which happen to include the CS features which to an external observer qualify them as representations of goals. A goal begins with a valued but unrealized state. Being rich, for example, is a state which for most people is not actual but is positively valued. When the intention to achieve this desirable state is added, we have a goal.

In MCF, the state is simply a conceptual representation, the concept of being rich. Its value is its connection to the value representation in AfS. A state representation is likely to be composite, possibly highly composite. It can take the form of BE X or POSSESS X or BE DIFFERENT FROM X or BE LIKED BY X, and so on. In each case X can be almost anything, simple or complex. Its 'not actual' status can be captured in an UNREALIZED representation that combines with it. The intention to achieve the valued state is captured in a basic, possibly primitive, CS representation, which we can call *SEEK*.[1,2,3] Individual goals will then have forms like *SEEK* (BE X), *SEEK* (POSSESS X), and so on. A simple example of a goal – the goal of eating a piece of cheesecake – is shown in Figure 4.1.

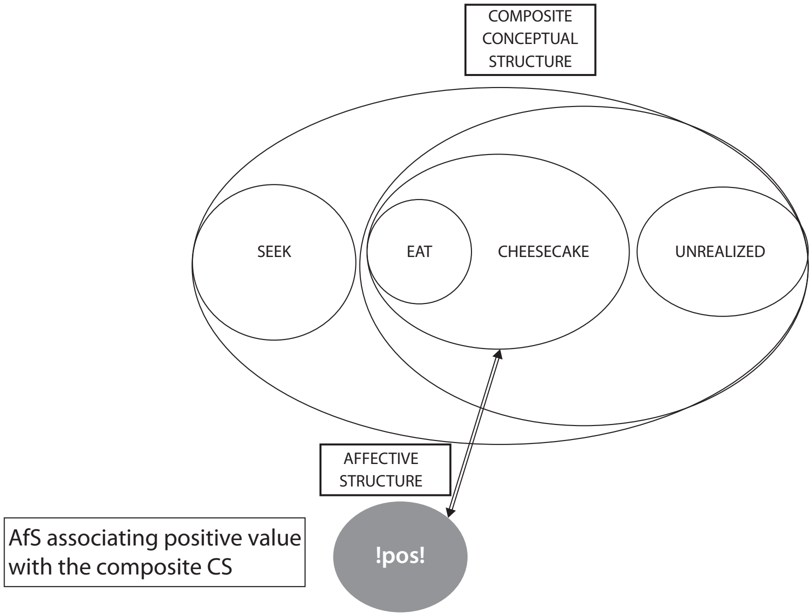

Figure 4.1 A basic example of a goal representation: Seeking a cheesecake

Accomplishment of any ordinary task will involve a number of subgoals in addition to the primary goal, i.e. the one that defines the task. The goal of eating a cheesecake, for example, might require subgoals of identifying a location where cheesecakes can be purchased, getting to the location, ordering the cheesecake, paying for it, and so on. Each goal, primary and sub, can be associated with linguistic, motor, affective, and perceptual representations. When a particular pattern like this becomes well established, we can speak of a schema, or *goal schema*: an established pattern of activation (i.e. a schema) that serves to achieve a particular

1. It is probably not an accident that our *SEEK* representation resembles Panksepp's (2005; Panksepp & Biven, 2012) hypothesis of SEEK as a basic emotion.

2. Some caution is required with the term. It is not clear how closely the *SEEK* representation corresponds to the standard meaning of the English word, or to a particular word in any language.

3. For the sake of relative simplicity, we treat negative goals, such as avoiding embarrassment, as seeking the negation of an undesired state (embarrassment), rather than hypothesizing a distinct type of goal involving an *AVOID* representation.

goal – the primary goal of the schema. It should be noted that subgoal and goal schema, and indeed goal itself, are not actual entities of the framework. They are, rather, ways of characterizing the behavior of the hypothesized system in terms of more familiar ways of understanding cognition.

One further clarification is needed. CS also includes a representation, GOAL, corresponding to the word 'goal' and serving as its meaning, but this is not what we are talking about here. It is the abstract concept of a goal, while the goals we are describing are the actual goals that shape behavior, often without our awareness or understanding of their influence.

Finally, we should note that goals have a significant place in cognitive neuroscience (e.g. Fuster, 2015). They are associated primarily with prefrontal cortex, particularly dorsal and lateral PFC.

2.2 Establishment of goal representations

Consider then how these goal representations might come about. The conceptual processor, carrying out its function of producing a single legitimate representation from whatever is active in its store, often has to deal with representations that are not directly reconcilable. When, for example, a positively valued representation POSSESS X is active along with I DON'T POSSESS X, one resolution is to activate *SEEK* and combine it with POSSESS X. The resulting representation is a goal, *SEEK* (POSSESS X). Crucially, there is no incompatibility between this new representation and I DON'T POSSESS X and therefore no issue for the processor. By the logic of MCF processing, the goal representation will also be associated with contextual representations that were active when it was formed. We will have more to say about the construction of goal representations below.

It is worth noting that the creation of a goal representation is not an inevitable consequence of an incompatibility between desire and reality. The conflict might also be removed by in effect reducing the positive value on having x: "I don't really care about having x" or "having x would create problems" or "x is really not that good after all". Another alternative is to fantasize about having x, the fantasy consisting of strong activation of a representation of having x. In its extreme form, this is a delusional state.

2.3 Conclusion

Goal representations, in the fairly broad sense in which we are using the term, are an inevitable part of processing and behavior. Their activation levels can be high, particularly in the case of goals that are frequently used and play an important role in the person's life, especially if they are integrated with others in a self representation and are associated with strong value (see below). They thus constitute a significant element of the internal context of processing in general, notably including bilingual language processing.

What we are offering is, again, a general framework for understanding and researching bilingual processing, which we consider a necessity if the field is ever to achieve genuine understanding. Because it is a framework rather than a theory, we necessarily leave open a great many details in a great many areas, one being the nature and operation of goals. The details can be filled in by adoption and/or development of specific theories. Valuable sources include, among many others, Baars, Fehling, LaPolla, & McGovern (1997), Carver & Scheier (1998), and Gollwitzer (1993, 1999; Gollwitzer & Brandstätter, 1997), along with the seminal work of Tolman (1932) and Miller, Galanter, & Pribram (1960). Anderson's (1993) production systems are also relevant. Bargh (2017) insightfully explores goals in the context of unconscious influences on behavior (see also Ferguson, 2008).

3. Value and emotion

To this point we have focused on goals, the most intelligent, most human elements of internal context. But internal context is also determined to a large extent by more basic elements of the human mind, particularly value and emotions. These elements are now widely recognized as integral parts of cognition (e.g. Barrett, Niedenthal, & Winkielman, 2005; Evans & Cruse, 2004; Izard, 2009; Lane & Nadel, 2000; Moore & Oaksford, 2002; Phelps, 2006; Storbeck & Clore, 2007), with the implication that they cannot be left out of or treated as separate from bilingual cognition either.

All the factors determining internal context, including both goals and affect, must be understood in terms of their biological roots, i.e. their role as life regulators (see especially Damasio, 2010). They originally developed to manage an organism's relations with its environment and its body, in order to facilitate survival and reproduction. In the modern human context, they continue to exert strong, general influences on thinking and behavior and thus constitute important elements of internal context. These influences naturally extend to bilingual processing.

3.1 Value

Value is the judgment of something as good or bad along with a degree of goodness or badness (see Damasio, 2010; Edelman, 1992, 2006a, 2006b). In addition to its inherent importance, it is generally seen as the most basic and universal element of emotions (see Barrett, 2005, 2017; Barrett & Russell, 1999; Frijda, 1986; Ortony, Clore, & Collins, 1988; Smith & Ellsworth, 1985). It also plays a central role in decision making and rational thought in general (see Damasio, 2010; Edelman, 1992, 2006b; Montague, 2006; Morrison & Salzman, 2010). Given its centrality in cognition and its crucial role in bilingual processing and acquisition, it has received remarkably little attention, typically appearing only implicitly in discussions of bilingualism.

In neural terms, value is based on projections from lower brain regions to prefrontal cortex, the heart of rational cognition (which, importantly, is inseparable from goals). These projections also include a variety of other regions throughout the cortex, the striatum, and lower regions associated with emotion (for related discussion see, among many others, Damasio, 2010; Edelman, 1992, 2006a, 2006b; Nobre & Mesulam, 2014; Roy, Shohamy, & Wager, 2012; Tettamanti et al., 2012). The amygdala plays a central role as evaluator of stimuli, which is to say it assigns value to them (Morrison & Salzman, 2010; Pessoa, 2014; Sander, Grafman, & Zalla, 2003; Sergerie, Chochol, & Armony, 2008).

Value is the most basic life regulator and perhaps the most fundamental feature of internal context, as everything we do or do not do is based on how we value the various objects, ideas, actions, etc. that are part of our lives and our thinking. Value labels everything that is encountered as good or bad for the organism and assigns a degree to the goodness or badness. Sources of food and shelter, for instance, will have high positive value while toxins and predators will have high negative value. In more sophisticated cases, high positive value is found with respect, affiliation, and art, among many others, while high negative value accompanies failure, humiliation, and social isolation, for example. This naturally extends to bilingual processing, as a bilingual can, for example, value each language to different degrees, often in different contexts, with important implications for language use. This point will assume considerable importance in subsequent chapters

As described in Chapter 2, value in the MCF framework is realized as two representations in affective structures, one positive and the other negative. If something, say a particular animal, is identified as bad for the organism, this means that representations of that animal are connected to the negative value representation. If a location has been identified as a source of food or shelter, representations of that location become connected to the positive value representation. The same description applies to more sophisticated cases like representations of positive or negative social situations or appreciation of art – or languages and their use. Once the connections have been established, they can exert a strong influence on use or avoidance of the valued representations. For present purposes, the implication is that these connections are an important part of the internal context of processing and should therefore have a prominent role in a study of bilingual processing.

3.2 Emotion

Closely related to value and similarly important as part of internal context is emotion, briefly introduced in Chapter 2, Section 6. Its importance in this role is clear from the dramatic effects that it obviously has on cognition and behavior, including what we say and how we say it. The enormous literature on the subject (e.g. Barrett, 2017; Damasio, 1994, 1999, 2003; Ekman, 2003; Evans, 2001; Evans & Cruse, 2004; Frijda, 1986, 1988/1998; LeDoux, 1996, 2015; Lundqvist & Öhman, 2005; Panksepp, 2005; Panksepp & Biven, 2012; Seager, 2002; Tooby & Cosmides, 1992; Turner, 2000) contains considerable controversy, so it is impossible to present the subject in a manner that is acceptable to everyone. But our treatment is broadly consistent with mainstream thinking.

Emotion is a value-based system in that the positive/negative dichotomy, with variable degrees of intensity, is the core of all emotions (for relevant discussion, see Barrett, 2005; Barrett & Russell, 1999; Frijda, 1986; Ortony, Clore, & Collins, 1988; Smith & Ellsworth, 1985). The basic function of the system is to connect perception to action in ways that enhance survival and reproduction. Fear, for example, connects perceptions of dangerous things or situations to the actions of fleeing, freezing, and appeasing. It thus contributes, greatly, to an organism's prospects for survival.

This function of connecting perceptions to appropriate actions requires some analysis of the perception and its context to determine which emotion best applies to the situation. This *appraisal*, in its most intelligent form, is a matter of abstract conceptual (CS) analysis, crucially involving the cortex. But we also have a more basic form, associated especially with the amygdala, as shown by the very fast, automatic and unconscious reactions we can make to emotional stimuli (LeDoux, 1996, 2015; Morris, DeGelder, Weiskrantz, & Dolan, 2001; Pegna et al., 2008; Tamietto et al., 2009; van den Stock et al., 2011).

We treat emotions as representations in affective structures (AfS), along with value. Beyond this, the contents of AfS are not entirely clear. A wide assortment of more primitive related mechanisms exist, associated with lower, older parts of the brain. The terms 'drive', 'motivation', and 'instinct' are all relevant here. Mechanisms include, among others, sexual desire, hunger, thirst, the sense of cold, loss of balance, itch, and fatigue (see Craig, 2003, for relevant discussion). All can reasonably, if uncertainly, be considered elements of AfS and components of internal context. We will restrict our attention, though, to value and emotions, the most generally important influences on processing, particularly on bilingual language processing.

It is clear from ordinary experience that emotions have great influence on cognition, subjective experience, and behavior, including linguistic behavior. This is expected, partly because they are tied to the body; in the words of Öhman (2006, p. 35), emotions "mobilize the body's metabolic resources for potentially vigorous action" (see also Johnston & Olson, 2015). The implication is that they are an important part of the internal context for processing. This significance extends to bilingual language processing, a point that shows in the attention that emotion receives in the field (e.g. Altarriba, 2013; Altarriba & Basnight-Brown, 2011; Dewaele, 2010; Dulay & Burt, 1977; Ivaz, Costa, & Duñabeitia, 2016; Kim & Starks, 2008; Krashen, 1985; Pavlenko, 2005b; Schumann, 1997; Sharwood Smith, 2014a; Sharwood Smith, 2017c; Wu & Thierry, 2012).

4. Self

Self is understood in many different ways, but however it is taken, it influences virtually everything that goes on in our thinking and behavior, including linguistic behavior. It thus constitutes an essential element of internal context. A general recognition exists in the literature that there is no single thing called 'self' and that what we commonly call 'self' is somewhat fluid and dynamic. So, any serious account of self necessarily involves a variety of complications. Here we will develop the idea of self within the logic of the MCF framework and its architecture. Before getting into these matters, though, it is necessary to consider the question of whether this somewhat contentious concept has a place in an inquiry of this sort.

4.1 Is self a legitimate object of scientific study?

The concept of self has had a checkered history (see Hood, 2012; Martin & Barresi, 2012), sometimes taking center stage in our efforts to understand ourselves and sometimes, especially in recent times, being dismissed as a myth with no place in a scientific account of human nature (Gazzaniga, 2011; Hood, 2012; Martin & Barresi, 2012). Critics point out that research has not produced any support for the traditional idea of self, i.e. for an indivisible, unchanging entity that provides unity and continuity to the person and exercises full control over our thoughts and actions. The apparent conclusion is that we need to understand ourselves in terms of these multiple controls, discarding the idea of self as lacking scientific value.

These critiques make valid and important points, the most important being that research has in fact shown that our thoughts and behavior are controlled by an assortment of factors, both internal and external and often unconscious. There does not seem to be any unified, unchanging entity corresponding to the traditional notion of self. At the same time, though, the idea of self has proven useful in a variety of research areas, including consciousness (Baars, 1988; Baars, Ramsøy, &

Laureys, 2003), memory (e.g. Conway, 2005; Tulving, 2002), life regulation (Damasio, 2010), will (e.g. Baumeister, Schmeichel, & Vohs, 2007; Baumeister & Tierney, 2011), and second language acquisition in its social (e.g. Mercer & Williams, 2014; Norton, 2013; Taylor, 2013) and motivational aspects (e.g. Dörnyei, 2009). It is also a prominent element of much neural research and theory (e.g. Craig, 2010; Damasio, 2010; Panksepp, 1998, 2007; Panksepp & Biven, 2012). We will suggest, throughout the remainder of the book, that it is also useful, and perhaps essential, in efforts to understand bilingual language processing.

Critiques of self may be best understood as grounds for substantive changes in the traditional concept rather than for its abandonment. While there is no indivisible, unchanging entity that provides unity and continuity to the person or exercises full control over our actions, the evidence is consistent with a more humble view of self: It is a set of relatively high-level, interacting regulatory systems that evolved to manage the many other systems that must co-exist within the one body; it is not entirely unified, has no monopoly on control, and does not remain unchanged through a person's lifetime or from one situation to another – but is nonetheless real and important. This is the starting point for an account of self.

4.2 Self as CS representation(s)

Much, though certainly not all, of what has traditionally been called self is best treated as conceptual in nature and therefore belonging to CS. Under this heading we include the goal-based, actor aspect and also the self-image aspect. We will consider each in turn. The affective aspect of self will be taken up in the following section.

4.2.1 *Self as a goal system*

Self has been treated in the literature as a goal structure, more or less as we have described it (e.g. Carver & Scheier, 1998; Conway, 2005). Such a view is intuitively appealing because to a very large extent the goals that we hold, often implicitly, determine how we behave and think and feel; in other words, they are, to a large extent, what we are. This conception has a natural place in the MCF framework.

To understand the organization of the goal system, we should first consider the innate character of CS, particularly the initial contents of the conceptual store. The store must begin with representations of basic desired states, their desirability identified by connections to value representations. These basic CS representations include both physical needs and social needs (respect, bonding, power…), and perhaps other types. The *SEEK* representation referred to above is also essential and appears to be quite basic and probably primitive. Because the basic desired and undesired states are the representations that are initially valued, they are the representations that will initially be combined with *SEEK*, forming goal representations. Self is then the structure that forms around this representation. What all the goal representations have in common is that they all include *SEEK* as their core.

The resulting structure is to some extent hierarchical because this process of forming goals means constructing representations that include *SEEK*, and representations that include those representations, and so on. But hierarchies are by no means sufficient to capture the structure of the goal-based self. Considerable overlap inevitably exists among the goals in the structure, based on shared representations within the states that each includes. Additional complexity comes from the association of varying context representations with individual goals. The result is an overall structure that includes hierarchical organization but is far more complex and chaotic than can be captured by a simple hierarchy or set of hierarchies – the self representation is by no means a simple, homogeneous entity. The relatively chaotic character of the system also comes from the fact that the component representations of the self can to some extent be activated independently and/or to different degrees and so can exert a greater or lesser influence on processing at different times (see Carver & Scheier, 1998; Conway, 2005).

This complexity will inevitably show in processing. Different goals will interact with one another. Contextual activity will selectively activate goals within the self structure, stimulating the whole structure but some parts of it much more than others. The component representations will also vary in their resting levels, differences coming initially from the differing activation levels before their incorporation in the self and partly from distinct activation patterns after the incorporation. One implication is that some goal representations included in the self will be more important than others in processing, their importance varying greatly with the particular context that is currently active.

These characteristics – structure and variable activation – match those that Conway (2005) attributed to his *working self*. Conway also stressed the interrelatedness of self and memory, an aspect we will take up shortly.

4.2.2 *The meta-self*

The goal-based self, as described in the previous section, consists of a system of goals that guide cognition and behavior. This account leaves out a number of aspects of self, as the idea is commonly understood. One crucial aspect is the knowledge or beliefs that one has about oneself, the set of self-concepts. These self-concepts together form what has been called the conceptual self (Neisser, 1997; see also Kihlstrom & Klein, 2006) or the autobiographical self (Damasio, 2010). Because the goal-based self is also conceptual, in that it is an element of CS, we will avoid the term 'conceptual self'. We will refer to it instead as the *meta-self*, as it is in essence a personal theory of oneself. As such, it is one instance of the general character of CS: the seat of abstract representations of the world and of other elements in the cognitive system. This meta-self co-exists with but is distinct from the goal-based self system described above.

A self-concept is a conceptual representation embodying some knowledge or belief about oneself: "I am a caring person" or "I am tall" or "I am a father" or "freedom is important to me". What makes them self-concepts is that they all share an abstract conceptual representation that can be called ME and are all formed by the combining of other conceptual representations with it: CARING PERSON + ME is the concept that I am a caring person, for example. The structure of the meta-self is illustrated in Figure 4.2, which of course only shows a tiny sample of component representations.

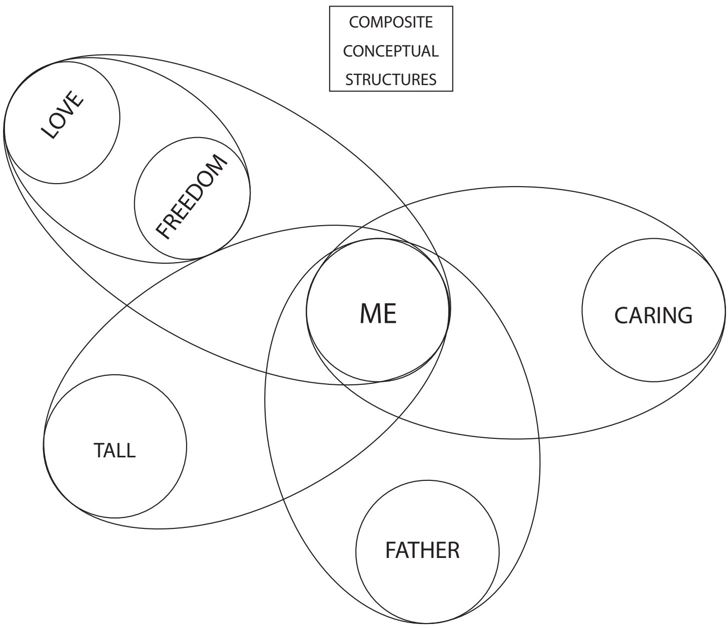

Figure 4.2 The meta-self

We should stress that ME and the representations formed from it are not to be confused with the goal system that is the core of the self. The ME representation is not the real me any more than my concept of Barack Obama is the real Barack Obama. ME is instead the *concept* of me. The complex representations that include it as a component form the meta-self.

The meta-self probably incorporates the various *possible selves* that have been proposed in the literature (e.g. Markus & Nurius, 1986) and have acquired a place in the study of second language learning (see below). These include the ideal self, the expected self, the hoped for self, the ought self, and the feared self. Each is primarily a conceptual analysis of possibilities rather than a goal structure, and so they are best seen as elements of the meta-self, distinguished from one another partly by their differing connections to AfS representations. It is quite possible that each will show some coherence as a significant component – that the expected self, for example, is a genuine component of the meta-self, consisting of a cluster of representations of characteristics with an EXPECTATION representation as its core. We will leave this as an open question, for the moment, returning to this topic below and, in more detail, in Chapter 8.

The establishment and development of the meta-self follows the same logic as that of the goal-based self. Because the various self-concept representations share the ME representation as their central component, they tend to be activated together and tend to activate one another to varying degrees. It is natural then that the conceptual processor forms composite representations from them and that these representations linger and solidify to the extent that they are subsequently used in processing (following APT). The product is one or more conceptual representations consisting of the abstract idea of self (ME) and a number of characteristics attributed to it. This is, again, the same logic by which the goal-based self system is established.

The meta-self inevitably interacts with the goal-based self. When a representation of a desired state is active along with representations of the fact that the state is not actual, it is natural for a goal representation to be formed (and become a part of the goal-based self), using the *SEEK* representation. These points have significant implications for the acquisition and use of a second language, as will become clear in subsequent chapters.

A note on terminology is important at this point. Given that there are (at least) two CS representations that can be legitimately referred to as 'self', a danger of confusion exists. Self as a relatively stable and coherent goal system, the primary concern, will be referred to as 'the goal-based self'. In referring to the system of self-knowledge or self-belief, we will speak of the 'meta-self'. To these we will add, in the following section, the affective self.

4.3 Self as affective representation(s)

As described above, the CS selves are highly composite conceptual representations consisting in one case of goals and in the other of concepts attributed to ME. In each case the component representations came together through repeated use in processing to produce a relatively coherent and relatively stable unit, the goal-based self in one case and the meta-self in the other. This development, we should stress, follows the standard logic of processing and APT. This same logic applies to the affect system. We should expect a large number of representations there to merge, through processing experience, into a highly composite representation. Such a representation, given its high activation levels (see below), should contribute to the relatively coherent and relatively stable patterns of cognition and behavior that typify an individual, just as the merging of higher-level goals into a CS self do. This highly composite AfS representation can reasonably be considered an affective self.

The concept of an affective self connects to important ideas in cognitive neuroscience. Damasio (2010; Parvizi & Damasio, 2001), for instance, hypothesized three selves, including a lower-level *protoself*, associated with the more basic life regulators, including emotions. Similar ideas have been developed by Panksepp (1998; Panksepp & Biven, 2012) and Craig (2010) (see also Edelman, 2006a, 2006b). The lower self has been associated with a variety of sub-cortical structures as well as medial cortex and the insula (see Craig, 2002, 2003, 2009, 2010; Damasio, 2010; Northoff et al., 2006; Panksepp & Biven, 2012). Fuster (2015) divided prefrontal cortex between orbital and medial on the one hand and dorsal and lateral on the other, the former involved in emotion and other lower-level functions, and this split can reasonably be associated with that between affective self and conceptual selves.

Representations of the sort we are hypothesizing should be expected to have very high activation levels. We noted above the high levels of emotion representations in themselves. The affective self, as a relatively coherent and relatively stable composite of these highly active representations, will itself enjoy extremely high activation levels, and these levels should be largely maintained throughout our waking experience, as perceptions and cognition in general inevitably involve value and affect.

An important implication, given the MCF account of consciousness (Truscott, 2015a, 2015b) is that the affective self representation should be a constant part of conscious experience. This is the idea of self as experiencer. Perhaps the most salient feature of self is in fact its role in conscious experience. Our experience is nearly always (if not literally always) in terms of self, and this conscious experience of self is essentially affective and value-based. The affective representations that make up the affective self are also a prominent and constant part of experience. Thus the experiencing self is affective. It is not conceptual. While goals have an important background role, they are not a direct part of conscious experience,[4] just as other conceptual representations are important contextual elements underpinning conscious experience without being directly part of it.

4. In Chapter 10 we will tentatively offer an important caveat on this conclusion.

4.4 What is 'self'?

It should be clear that there is no one thing that corresponds to the word 'self'. We have to distinguish, first, between self as conceptual representation(s) and self as affective representation(s). At each level a large number of related representations come together to form a self, which serves to bring a degree of coherence and stability to processing in its module. Within CS we need to distinguish between the basic goal-based self and the meta-self. Finally, each type of self can be multiple, though in non-pathological cases at least the multiple selves overlap far more than they differ.

But while these distinctions are essential, interactions among self systems must also be recognized. The goal-based self and the meta-self inevitably have a great deal of overlap between them, particularly at low levels of component representations. Representations like LOVE and MONEY, for example, are likely to be included both in goals that are components of self and in the self-images of the meta-self. Aspects of the meta-self that are desired but not actual can trigger the creation of goals to achieve them, and aspects that are actual but undesirable can lead to goals of eliminating them. Interactions with the affective self are also extensive and crucial. Goals in CS are driven by, and to some extent created by, the values and emotions in AfS. Affect is in turn partly shaped and activated by the appraisals and other relatively rational judgments occurring at the conceptual level. Processing, experience, and behavior inevitably reflect the combined effects of conceptual and affective activity, and therefore of the selves which dominate and give coherence to that activity.

An interesting question, then is the extent to which CS and AfS selves behave like an integrated unit. Given their shared function of guiding cognition and behavior, ultimately based on goals (in the broadest sense of the term) that facilitate survival and reproduction, and their inevitable coactivation throughout processing experience, a considerable degree of functional integration should be expected. In MCF the integration is, as always, based on coindexation across levels. If the integration is especially tight it is because the coindexation between CS and AfS selves is rich and the indexes have high resting activation levels. The extent to which this is true is necessarily left as an open question for the time-being.

4.5 Self and bilingualism

A substantial literature exists on issues related to self and identity in bilingualism and second language learning. For our purposes two major strands can be identified in such work.[5] One of these strands is, in our terms, about the meta-self and its interactions with the goal-based and affective selves, particularly how second language acquisition is influenced by these factors. The other involves the familiar idea that the bilingual can in a sense be two different people depending on which language he/she is using at the time.

4.5.1 *Self and language learning motivation*

The acquisition strand makes use of the concepts of ideal self and ought-to self described above, specifically as they are incorporated by Dörnyei in his account of motivation, the 'L2 motivational self system' (see Dörnyei, 2009; Dörnyei & Csizér, 2002). The ideal L2 self represents what the person would like to be in regard to the language. The ought-to self is a reflection of external expectations: "the attributes that one believes one *ought to* possess to meet expectations and to *avoid* possible negative outcomes" (Dörnyei, 2009, p. 29). Discrepancy between perceptions of actual self on the one hand and ideal and ought-to selves on the other provides motivation for learning.

We explained possible selves, above, as components of the meta-self, interacting with the goal-based self and the affective self. Each possible-self representation has strong connections to value representations in affective structures. The ideal self is of course associated with positive value. Following Dörnyei's treatment of the ought-to self as a matter of avoiding negative consequences, an important role will be played by negative value associated with representations of such consequences. Dörnyei and Ushioda (2009) raised the possibility that a number of distinct ideal and ought-to selves exist, but left it as an open question. For our account this is largely a question of how integrated the representations are. Does the meta-self representation directly contain multiple distinct representations of the ideal (ought-to) self or just one such representation, itself possibly containing representations of distinct ideal (ought-to) selves?

The motivational aspect of the possible selves comes from their influence on goals, i.e. on the goal-based self. The representation constituting the ideal self is positively valued, so when it is active along with a representation of its non-reality, a natural (though not necessary – see above) consequence is the construction of a goal representation, constituting the intention to become the ideal. If this general goal leads to establishment of the more specific goals needed to bring it about, the result can be substantial benefits for learning. We will return to these points in Chapter 8.

5. These two strands are by no means the full story of research in this area. See for example the many papers in Csizér & Magid (2014) and Mercer & Williams (2014).

4.5.2 *Multiple selves in bilingualism*

A common observation is that bilinguals often feel different when they are speaking one of their languages than they do when speaking the other(s). They have, in a sense, two different selves or identities, one associated with each language (for relevant discussion see, e.g., Ervin, 1964; Grosjean, 1982, 2010; Hemmi, 2014; Norton, 2013). This observation also suggests that self distinctions are a significant factor in the internal context of bilingual processing.

A substantial literature exists on the idea of multiple selves, usually involving pathological cases and/or hypnosis (e.g. Carter, 2008; Hilgard, 1986; Kihlstrom, 1987, 1997; Kluft, 1996; Rieber, 2006; Whalen & Nash, 1996). But while the idea of multiple selves has traditionally been associated with pathological cases, it also characterizes, in a weaker form, ordinary people in ordinary life (e.g. Carter, 2008). Here the differing personalities mainly reflect the different situations that an individual must deal with and their differing needs in those situations. We are not entirely the same person in the home environment as in the work environment, for example. In the same way, we are not entirely the same person – self – when using one language as we are when using another.

The intuitive notion of 'self' we are referring to here must be understood in terms of all three types of self representations and their relations to one another. If the goal-based self, the immediate guide for thought and behavior, is divided, its different parts are likely to have different connections to AfS representations, resulting in different emotions and different conscious experiences in general when different selves are dominant. The meta-self is intimately associated with both of the other selves, in general and in this case. A person routinely dealing with two different types of situations (home and work, for example), and feeling and acting differently in them, is likely to form distinct self concepts accordingly.

Consider then how multiple selves develop and function in bilinguals, particularly how they relate to bilingual language processing. We have suggested that different selves develop in different contexts, reflecting the needs of those differing contexts. We also know that different contexts tend to involve the use of different languages (the Complementarity Principle of Grosjean, 2010, 2016). What this suggests, in our terms, is that bilinguals are likely to have distinct (if greatly overlapping) self representations corresponding to the distinct situations in which they tend to use their languages.

Second language learning should often involve the development of a second language self. The extent to which this development does occur should reflect the extent to which the second language is serving functions distinct from those of the first, in situations distinct from those in which the first is used. There is, no doubt, considerable variation among individual learners in this respect and others. Some learners may, for instance, be more resistant to development of an L2 self. These considerations touch on the classic integrative/instrumental distinction (see Gardner & Lambert, 1972). Integrative motivation leads a learner toward immersion in the L2 culture and ways of thinking associated with it, the likely consequence being development of a strong L2 self, while instrumental motivation allows the learner to use the L2 without any such change because language learning is purely for practical purposes.

Grosjean (2010) has argued that the phenomena for which language-based selves are invoked can be explained in terms of the Complementarity Principle without reference to the languages as such, simply by the fact that the two languages are associated with differing situations and purposes – people behave differently in different situations, regardless of the language they are speaking. In our terms, this would mean that while distinct self representations exist in bilinguals, corresponding to their distinct languages, they do not differ, or perhaps do not differ to any great extent, from those that exist in monolinguals who deal with similarly varied situations in their lives. For our purposes the main point is that the internal context of bilingual processing can include distinct selves associated with the different languages, whether or not the selves are a consequence of the bilinguality.

The point can be extended to the possibility of second language *meta*-selves. If the languages are used in distinct situations for distinct purposes, as is likely, distinct meta-selves could well develop, in essentially the way described above and with the high degree of variability suggested there. We will return to these topics in the following chapters.

5. Conclusion

The inherent elements of internal context are goals, self (selves, actually), value, and affect. All are representations in CS or AfS, though connections across these modules and with perceptual and motor representations must also be recognized, especially if we want to take into account the intuitive notions of these elements. As these representations are almost always active, often highly active, they inevitably influence processing all through the system. This is to say that our thinking and behavior are normally influenced, very strongly, by our goals, values, and emotions, and by the selves we have developed from these elements. Because of this, it is hard to justify excluding these important influences from discussions aimed at explaining some syntactic or phonological phenomena or indeed from the design of experiments investigating any aspects of linguistic behavior such as code-switching, crosslinguistic influence, and language attrition. A crossdisciplinary framework can assist the integration of these contributing factors into accounts of bilingual performance and development.

In our terms, the influence of these factors extends to the linguistic modules. Goals are conceptual representations and therefore can be directly involved in construction of the message that is being derived in language comprehension or that constitutes the idea to be expressed in language production. CS is also home to the goal-based self and the meta-self, which because of their high activation levels necessarily exert a strong influence on all CS activity, including that which directly connects to linguistic processing. The framework does not hypothesize any direct connections between AfS and the linguistic modules, so the influence here is more indirect, via the interface between affective and conceptual representations. So active representations of emotion and value, positive or negative, can be expected to exert a strong influence on language use. The affective self is a composite of AfS representations, so its relevance to language use is also clear, though in practice this influence is difficult to separate from that of the CS goal-based self.

These factors, along with those of outside-in context, constitute the internal context of (bilingual) language processing. We feel that much of the current literature on language acquisition, language attrition, and bilingualism is impoverished by not consistently taking into account the issues of goals, self, value, and affect. Although, as we have already indicated, much has been written in separate contexts about the influence of self, affect and motivation on learning and using languages, these topics are too important to be dealt with only as independent topics. The general trend should now be to develop a more comprehensive and integrated approach. In this spirit, the nature of their influence is the topic of the following chapters.

Finally, because this chapter includes a number of potentially confusing concepts, we present here a brief summary of key terms.

SEEK: a CS representation, probably an innate primitive. It is not necessarily the same representation that constitutes the meaning of the English word *seek*.

goal: a CS representation consisting of *SEEK* and one or more representations of a valued but unrealized state (note that 'state' has a very broad meaning here).

goal schema: an established pattern of activation across modules (i.e. a schema) that serves to achieve a particular goal – the primary goal of the schema.

subgoal: A goal representation that is seen as contributing to achievement of another goal. When a goal schema is active, a subgoal is any goal representation that is part of the schema but is not the primary goal. In terms of its structure and activity, a subgoal is simply a goal, no different from any other goal. Any goal can be a subgoal in a given instance and then cease to be a subgoal when CS activity changes.

goal-based self: a semi-structured composite CS representation consisting of a very large number of goal representations. It is the 'actor' self.

GOAL: a CS representation of the abstract concept of a goal. It is not itself a goal, any more than the concept of red is the perceptual experience of red or the abstract idea of fear is fear, or the concept of Barack Obama is Barack Obama.

ME: a CS representation of the abstract concept of the self; possibly an innate primitive.

meta-self: a large composite CS representation consisting of ME combined with representations of characteristics attributed to the person: I am X, I am not X. This is what is commonly called the 'conceptual self'. It probably includes representations of 'I should (not) be X', 'I hope to be X', 'I fear becoming X'… (the ought to self, the hoped for self, the feared self…).

affective self: a large semi-structured composite AfS representation consisting of various affective representations corresponding to basic drives, urges, motivations, emotions, and so on. It is the conscious experiencer.

CHAPTER 5

Bilingual representation

1. Introduction: The significance of bilingual representation

One important theme running though this book is that bilingual representation follows the same principles as monolingual representation. This means that, despite the fact that outcomes of acquiring and processing one or more languages will differ, there are no adaptations required for one mind to accommodate more than one language system. Exposure to a new language results in the growth of many new connections but all within the same modular architecture that handled monolingual development. Processing continues as before.

We begin with a short discussion of syntactic and phonological representation in the bilingual mind. The main emphasis in this chapter, however, will be on *conceptual* processing because of its central role in our account of internal context. Topics will also include metalinguistic processing and our interpretation of the main hypotheses and models that have been proposed in the psycholinguistic literature, keeping in mind the function of broad-based frameworks like the MCF in anchoring and contextualizing debates about the nature of various aspects of bilingual processing within the broader perspective of cognitive scientific research as a whole.

2. Syntactic and phonological representation in the bilingual mind

2.1 How is human language to be defined?

This section will briefly summarize the nature and function of the two modules that comprise the system which, in the MCF, is called the core language system and elsewhere, especially in the generative literature, is known as 'the' language module. In fact, following Jackendoff, it is actually a *bimodular* system although there are some relatively minor departures from Jackendoff's architecture in how these two components of the language faculty interact with other nonlinguistic modules outside the core linguistic system. This is our very much preferred instantiation of a particular theoretical linguistic approach within MCF architecture; it does not rule out a different approach being adopted to how inborn human linguistic ability could be incorporated in the MCF such as the Minimalist Program. However, we know of no approach that is yet sufficiently adapted and elaborated in order to accommodate both representation and processing in explanations of grammatical performance and development.

We also repeat here for the sake of absolute clarity on the matter and for the reader's convenience two important points. Firstly, the word 'language' in 'language module' and 'language faculty' is very misleading taken out of context. In both cases, it refers only to specific aspects of language, unlike the far more inclusive way in which the term is more often used. The term 'core linguistic' we use here underlines this fact. It comprises only two of the modules of the many involved in language processing.

The second point is related to the first one. Modules directly and indirectly linked to the core (syntactic and phonological) modules are termed 'non-linguistic' not because they play no role in language representation and processing – the opposite is the case – but because they also handle representations that are not involved in language. This will be illustrated in the following two sections and indeed in all parts of the book where context is discussed. The bottom line, as we have said before and will say again, is that 'language' is a concept much wider than syntax or phonology and that the whole mind gets involved during language activity, not just the one or two modules referred to in the generative literature that deal exclusively with language processing. It is a pity in retrospect that terms like 'language module' and 'language acquisition device' were devised since they can so easily be misinterpreted. The logic behind this usage is simply that it refers to the set of properties that make any language system specifically human.

Finally, as is crucial in discussing bilingual representations, it should be emphasized at the outset that the two core language modules are 'blind' as to which language the representations that they are processing belong to. This holds for production as well as comprehension processing. There are no internal tags that label representations as, say, French or Tagalog or Romanian. Language identity is established outside the core language system. The syntactic and phonological systems can carry on their processing blindly, rapidly and efficiently. This also carries implications for discussions about the bilingual 'mental lexicon' which will also be mentioned below.

2.2 Syntactic representations in the bilingual mind

Syntactic representations known as syntactic structures (SS) are stored and processed in the syntax module's store, one of the two components of the core language system. The principles according to which the syntactic processor operates and the precise nature of the innate syntactic primitives that are available in its initial state are a matter for the preferred linguistic theory and not for the MCF. In any case, as is the case with every other module, perceptual or otherwise, the processor works only with whatever structures are currently active, i.e. in its working memory, that is to say both its innate categories (primitives) and combinations thereof, and it assembles them in lawful ways according to its internal principles. Whichever combination of syntactic structures eventually comes to dominate will fall out from the activity of the relevant interfaces as whole chains and networks of associated representations are activated in parallel.

The syntax module naturally has rich connections with its fellow module, that is, with the phonological system. In comprehension the activation of any given PS (whichever language system the activated phonological structure happens to belong to) will constitute input into the syntactic module triggering a response as various PS/SS associations are activated to provide candidates for that input. However, very often more associations with a given PS will have been formed with the SS in question. Even within one language there will be stiff competition where this is the case. For example, the PS /top/ (top) in English will be coindexed both with a noun SS and verb SS, say **N** and **V**. Which will fit best on this occasion? The resting level of activation (RLA) may play a decisive role. Prior experience may have established the /top/ ⇔ **N**[1] association as the dominant one because its RLA has been built up due to more frequent processing in the past. In other words, for the individual in question, 'top' is most likely to be a noun. As the PS and SS systems continue to interact via their mutual interface and as more PS input arrives to have syntactic structure assigned, an initially selected V, for example may prove to be a better fit *in* the now more complex representation than the other one, N, originally in lead position in syntactic working memory. For example, processing of what follows 'top' may reveal more about the syntactic status of /top/ as in "Top that, if you can!" in which 'top' turns out to be a verb. The syntactic processor continually works to combine SS currently present in its working memory on a best-fit basis and as more phonological input is processed more structures are there to be made syntactic sense of.

So far only monolingual syntactic structures have been mentioned[2] but exactly the same holds for syntactic representations that have been created in response to input from more than one language. Since in a bilingual's mind, we now assume that all languages are activated to a greater or lesser degree irrespective of the

1. These two interfaced structures will naturally have identical indices. However, we will dispense with coindexation details in such examples.

2. Strictly speaking, monolinguals also possess alternative systems in that they may have different varieties of the language, different registers, and even dialects and accents at their disposal making monolinguals effectively 'multilinguals' in some limited sense.

language currently in use, this means that at any given moment there will be competition in syntactic working memory of even more syntactic representations than would be the case in a monolingual. This situation is replicated in the bilingual's phonological working memory and in fact in all working memories participating in online language processing. The more languages an individual knows, the greater will be the number of competing items in his or her working memories, though the number will of course be significantly affected by the amount of overlap between languages.

The syntactic module also has a direct interface, and rich interconnections with the conceptual module. Even though the conceptual system is a generic one,[3] i.e. in MCF terms a non-linguistic system handling non-linguistic meanings as well, we may still assume that a vast number of CS in the conceptual store ('concepticon') will have been created as a result of interactions with SS/PS chains. Some of these CS will have more than one SS/PS association. In some cases, more than one language may also be involved. Although a word in one language and its closest equivalent in another should have some conceptual structure in common, it is likely that a fuller conceptual representation of each of them will reveal differences, Spanish 'casa' and 'house', for example, will turn out to have complex conceptual representations that will overlap but not be identical (for relevant research see, for example, Ameel, Malt, Storms, & van Assche, 2009; Ameel, Storms, Malt, & Sloman, 2005; Storms, Ameel, & Malt, 2015). In more traditional linguistic terms, they will be semantic equivalents or at least close equivalents but may be pragmatically quite distinct because they are used in different ways depending on the context.

2.3 Phonological representations in the bilingual mind

Phonological representations (PS) are stored and processed in the phonology module, one of the two components of the core language system. Most of what was said in the previous section holds for PS as well. The phonological module does not (*pace* Jackendoff) have a direct interface with the conceptual module but it does have rich interconnection via the AS/PS interface with the auditory module. Speech sounds, whatever language they happen to belong to, get their

3. The auditory module is also a 'generic' module, in the sense that it is a perceptual module handling all kinds of sound. It does interface with a module dedicated to linguistic sound, i.e. speech processing. In the case of the conceptual system, however, there is no need for an equivalent module handling only 'linguistic meaning'. Recall that the 'phonological' module can also handle input from other perceptual systems, in particular the visual system for sign language processing (see Section 4 below).

generic auditory representation in the auditory system and these AS get their phonological representations via the AS/PS interface. It is further assumed in the MCF, reflecting the association in the sign language literature of both speech *and* sign processing with 'phonology', that there is also a direct VS/PS interface, i.e. between the phonological module and the visual module (Sandler, 2012). If this is the case then potentially any sensory perceptual system could be recruited for language processing although it is hard to see how the olfactory system could ever be used for this purpose. This means, that the syntactic module only has two interfaces, namely (1) an internal one, that is to say one linking it to its partner within the core language system, i.e. the phonological module, and (2) an interface linking it to the generic conceptual module outside the core language system.

Speech sounds can of course be identified as belonging, or not belonging to a specific language system although in the first few months of simultaneous bilingual L2 acquisition there is no such differentiation but soon, languages get differentiated (Werker & Byers-Heinlein, 2008). In MCF terms, alternative sets of associations begin to form, each set being associated with one language system with its own specific PS/SS chains of association. This differentiation process may be accompanied by a greater or lesser degree of metalinguistic knowledge formed in the conceptual module where the concept of distinct languages gets represented permitting the individual to have an awareness of what a language is and of the existence of different languages. Metalinguistic knowledge will be discussed in more detail later in this chapter.

2.4 Reconceptualizing the bilingual mental lexicon

The mental lexicon is a construct that has been widely used in the psychological and linguistic literature for several decades; it can only be explained in any detail by resorting to one or other of the various theories about how words are stored, or rather how the properties that make up a word are stored and processed. Some are instantly relatable to MCF architecture in that they are theories about semantic memory, Quillian's theory being an early example (Collins & Quillian, 1969). As such they can be interpreted here as theories about how storage and activation operate within the conceptual module.

As will have become clear by now there is no single lexicon or single memory store anywhere in the MCF so the idea behind the mental lexicon, bilingual or otherwise, has to be reconfigured in terms of (MCF) modular architecture. The traditional practice of seeing individual lexical items as linguistic entities in their own right has proved convenient for psycholinguists and psychologists in general who wish to limit themselves to less complex linguistic units for understandably practical reasons. It is also a fact that there are theoretical linguistic ways of representing words in some sense as separate units. Despite this, this straightforward notion of a lexicon should not be taken as a safe assumption.

In our framework, the lexicon is again an abstraction. In line with Jackendovian architecture, words are themselves composed of representational units each of which, in processing terms, is stored and processed by a different modular system and therefore written in mutually incompatible codes. In this way, a word is composed minimally of a phonological representation (PS), a syntactic representation (SS) and a conceptual representation (CS). In theoretical linguistic terms then, this means that there are at least three linked units for each single word, each of these linked units coming from entirely separate 'lexical' stores, i.e. not bunched together in anything like the traditional single lexicon.

What have been hitherto referred to as 'stores', in each case a component in the basic design of any mental module, can also be thought of as specialist lexicons. For example, the syntactic store is a 'syntacticon', a term that is not new (for example Emonds, 2000), and it contains only SS representations. The store that contains various combinations of PS could be thought of as the 'phonologicon', and so on. In both cases there will be particular representations that have been created in response to input from one or other of the language systems to which a given bilingual has been exposed. The PS/SS association created in response to the Spanish word, 'casa', i.e. /kasa/⇔**N**, will be formed in the same two stores as its translation equivalent /haus/⇔**N**. In other words, there are no 'Spanish stores' for phonology and for syntax that are separate from 'English' equivalents. Lexical items from different languages are handled by a single set of stores and processors.

Lexical items are of course much more than the simple PS/SS chains in these two examples: These chains are participants in a larger network of representations (schemas) extending beyond the core language system, to include for example the auditory and visual modules. Most importantly, the chains include representations formed and stored in the conceptual module, the special topic of the next section. This basically means that the much debated issue of whether there is a combined mental lexicon for all languages or whether there is one for each may both be expressed in MCF terms although it has to be reinterpreted to fit its modular architecture. The result is that you can basically see it as follows: There are no separate lexicons, i.e. one for each language. In other words, no additional systems are required when considering bilinguals of any kind.

What are generally known as 'lexical items' in different languages are still differentiated, in part, by means of the (co)indexing system and a shared, i.e. identical or similar conceptual representation. Any chunk of phonological structure will have a unique set of associations across the stores of various modules but the sounds and visual signs associated with a particular language, represented as AS and VS respectively, will tend to coactivate each other partly because they will share a CS that acts as a language identifier. In other words, seen from the point of coactivation patterns, languages are, unsurprisingly, distinguishable so that words belonging to one language will have shared patterns of coactivation that differentiate them from words belonging to another language.

Overall, the bilingual mind's modular architecture handles all words irrespective of their origin but still allows words belonging to one particular language to have shared characteristics that distinguish them from words belonging to another. We will return later in the chapter to how various modules of the bilingual lexicon can be interpreted within the MCF.

3. Conceptual representation in the bilingual mind

We turn now to the conceptual system, which in one sense is just another module alongside all the other modular systems in the mind, like them composed of a processor with its own set of principles for managing representations, a dedicated store where these representations (CS) are created, stored and activated and finally interfaces connecting it with other modules. In another sense, it is the most important module in any discussion of internal context as it acts as the crossroads or hub where linguistic processing interacts with its cognitive context. This special role will be explored in detail in the following chapters.

Conceptual representations (CS) will inevitably feature in all kinds of context in discussions of bilingual processing. In language production, the idea to be expressed in an utterance is a conceptual representation and the end result of language comprehension is also a conceptual representation. As mentioned in Chapter 2, metalinguistic knowledge also takes the form of CS representations. This means that any metalinguistic influence on comprehension or production processing comes from CS. Again, the syntax module has no external connections other than CS (see Figure 2.5 of Chapter 2 and the accompanying text), so influences from other modules come largely through CS. It therefore follows that, if we are interested in contextual influences on linguistic processing – internal context – CS has to be the focus. It provides the raw material with which the various contextual factors work; it can also be seen as the stage on which they work.

In this third section we will consider some aspects of the conceptual system that are important for understanding this role, beginning with general characteristics of conceptual representation, and then look more specifically at bilingual representation. An open question is whether there is a single conceptual module or a number of more specialized modules, the latter option following the logic of evolutionary psychologists (e.g. Cosmides & Tooby, 2013; Pinker, 1997). In order to avoid the complications involved in identifying the narrow conceptual modules and determining how they might interact, we will adopt as a working assumption in this discussion the view that there is only a single conceptual module.

3.1 Conceptual representation

The conceptual system is commonly characterized as amodal, meaning that its representations are not in the encoding of any specific sensory modality but rather in a more abstract, neutral form. This makes perfect sense within the current modular architecture since representations in any MCF module, not just the sensory ones, are encoded in a manner unique to that module. But while conceptual representations do not belong to any modality, they necessarily interact, as already mentioned, via their mutual interfaces with representations in the various sensory modules. The conceptual representation of 'horse', for example, is associated with visual images of horses, auditory representations of sounds that horses make, and for those who have experience with horses, representations of their smell and the feel of touching them, possibly with motor representations of the actions involved in mounting and riding them. When one of these representations is activated the others follow, to varying degrees depending on their resting levels and other concurrent activity.

3.1.1 *The conceptual system in the brain*

There is considerable reason to believe that a conceptual system of the sort we have hypothesized does exist, i.e. that conceptual representation and processing are distinct from representation and processing in any of the various more specific functional domains. While our main focus is on the psychological level of description, this level can be aligned with the neural level. Probably the best evidence at this point comes from neuropsychological research, looking at selective effects of brain damage (Martin & Romani, 1994; Martin, Shelton, & Yaffee, 1994; Romani & Martin, 1999; Wong & Law, 2008). Additional evidence comes from behavioral research (Shivde & Anderson, 2011). All this work indicates that conceptual representations exist and are activated and kept active independently of other types of representations.

In neural work, the conceptual system is sometimes described as a *semantic hub*,[4] connecting representations in the various sensory modalities as well as motor areas. Based on extensive research, the hub has been associated with the anterior temporal lobe (Jackson, Lambon Ralph, & Pobric, 2015; Lambon Ralph, Sage, Jones, & Mayberry, 2010; McClelland & Rogers, 2003; Pobric, Jefferies, &

4. 'Semantic' here in the broader sense as used outside linguistics (see related discussion in Chapter 2).

Lambon Ralph, 2010). Other research (e.g. Fiebach, Friederici, Smith, & Swinney, 2007; Pietrini et al., 2004), while consistent with the hub idea, has produced somewhat differing conclusions about it, identifying posterior temporal areas that appear to contain supramodal object representations.

Prominent neurally-oriented theories of conceptual structure[5] include Binder and Desai (2011) and Jefferies (2013). Binder and Desai proposed that regions of prefrontal cortex "control the goal-directed activation and selection of the information stored in temporoparietal cortices" (p. 531). The phrase "goal-directed activation" is particularly significant here, as will become clear in subsequent chapters. The proposal by Jefferies (2013) was similar in that it involved prefrontal areas activating and controlling posterior cortical areas that were taken as the storage sites of semantic representations, though significant differences exist in the specific sites proposed.

Important contributions to this research area come from Ferstl and associates, who have developed the notion of an *extended language network* (ELN; Ferstl, 2006, 2007; Ferstl, Neumann, Bogler, & von Cramon, 2008). Ferstl reviewed the literature in 2007 and in 2008, and together with her associates published a meta-analysis of studies related to text comprehension. The assumptions were that functionally related areas of the cortex are coactivated and the meta-analysis looked at the cortical centers that were implicated in the majority of relevant studies. The conclusion was that a wide-ranging network was involved that employed a number of different areas in the prefrontal cortex although the relative contributions of the left and right hemisphere remain controversial. Predictably, more than one center within the PFC was found to be implicated in the research of the ELN with the dorsomedial prefrontal cortex (dmPFC) apparently playing an important role. This finding was supported in a later study by Ferstl (2010) when more studies were available than were used in the earlier meta-analysis.

It is certainly the prefrontal cortex (PFC) where we would locate primary control over CS processing, the conceptual system being the prime location for the processing of context. The dmPFC also happens to be associated with the sense of self and the Theory of Mind both of which should be important in context comprehension. This hypothesized role of the PFC and particularly dmPFC also fits well with Fuster's (2015) authoritative account of cognitive control, which we will consider in Chapter 6.

This leaves the question of how to interpret more posterior areas, temporal and parietal, which are clearly involved in conceptual processing, as already described. The apparent answer is implicit in the above discussion. Neuroscientific

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5. For a more cognitively-oriented approach to conceptual (semantic) memory, see Taylor, Devereux, and Tyler (2011).

work on control commonly treats prefrontal areas as control centers manipulating posterior areas that constitute the information to be used in processing. Applying this idea to the conceptual module of MCF, the natural if somewhat tentative conclusion is that the conceptual processor is found in PFC, and particularly dmPFC, while the conceptual representations it manipulates – the CS store – are located in posterior areas. We will return to these points in Chapter 6.

3.1.2 *Locating memory categories within the framework*

In MCF terms CS, like any other module, consists of a processor and a store of representations. The latter are of course in the distinctive conceptual code of the module. They include representations of all concepts that the individual has, with the potential for further combinations that will yield new concepts, without limit. They can embody knowledge and beliefs, both true and false, as well as memories that are conceptual in nature. These memories constitute what psychologists commonly refer to as *semantic memory*,[6] in contrast to *episodic memory* (Tulving, 1972, 2002; see also, e.g., Clayton, Salwiczek, & Dickinson, 2007; Dere et al., 2006; Eichenbaum, 2003; Platel et al., 2003). A conceptual (semantic) memory is one that is divorced from the experience in which it was acquired: Knowing that you got married on a particular date in a particular place is a conceptual memory; re-experiencing the events in your mind is an episodic memory. Closely related to the episodic-semantic distinction is that between remembering something and knowing it (e.g. Gardiner, Ramponi, & Richardson-Klavehn, 1998). Semantic memories are specifically CS representations, while an episodic memory consists of representations in several modules, held together initially by association with the AfS self and by association with one or more abstract CS representations (i.e. semantic memories). All these CS representations, along with goal representations, together constitute the material that is activated and used in the establishment of internal context.

3.1.3 *Conceptual primitives*

An important question in this context is the initial state of CS, particularly of its store – what are the innate contents of the conceptual store? First, it must contain the set of primitives from which concepts are formed. There is not yet, to our knowledge, a convincing account of exactly what these primitives are, and we will not try to resolve the issue here (for relevant discussion, see Goddard &

6. Again, 'semantic' in the more inclusive sense used in psychology as opposed to its use in linguistics. The MCF use of 'conceptual' is like the more inclusive sense of 'semantic'. The question here is about what a conceptual memory (representation) is or is not associated with *outside* the conceptual system.

Wierzbicka, 1994; Jackendoff, 1990; Miller, 1995; Pinker, 2007; Wierzbicka, 1996). But if CS is to fulfill its function of connecting perception to action in ways that will facilitate survival and reproduction, some things it must contain are representations of basic states that the organism (person) needs to achieve or maintain, a way of labelling them as desired states, and means of establishing a goal system that will make them targets for behavior and provide means by which they can be achieved. We will develop these points in more detail below.

3.2 Metalinguistic knowledge

As described in Chapter 2, CS contains not only the meanings of linguistic items but also conceptual representations of information about language, i.e. *metalinguistic knowledge* (see Sharwood Smith & Truscott, 2014b, Chapter 5, for more detailed discussion than we can offer here). A natural starting point for metalinguistic knowledge is the concept WORD, which is simply a CS representation. It can be combined with any number of other CS representations to form specific concepts about characteristics of the language. These other representations might include for example SOUND, MEANING, NOUN, VERB, SENTENCE, PHRASE, TRANSITIVE. It should be stressed that WORD is the *concept* of word; it is not a word any more than the concept of a polar bear is a polar bear. The same can be said for all the other CS representations that constitute metalinguistic knowledge.

Combinations of these various representations can express essentially any knowledge or belief about the language, for example, the concept that the word 'kiss' is a transitive verb or that adjectives precede nouns in English. Furthermore, following on from what was just mentioned about WORD being a concept, the metalinguistic 'word' must of course be sharply distinguished from the representational chains and networks that make up the composite structure of what we know, metalinguistically, as a single word like *kiss*. Word learning in its most basic sense is making associations between given chunks of phonology, i.e. PS, and concepts, i.e. CS. Inevitably there will also be an attempt by the intervening syntactic system to supply a candidate SS to form a chain of three (PP⇔SS⇔CS).

3.3 Bilingual conceptual structures

The question was raised earlier about how the bilingual mental lexicon should be characterized within the present framework. How two or more languages of the bilingual are represented in terms of meaning is, in fact, a central issue for the study of bilingual processing so the matter should be considered more closely. More specifically, what is the relation between L1 conceptual representations and L2 conceptual representations or indeed L3 ones? The character of MCF architecture and processing suggests a variety of ways in which meaning representations of the bilingual's two languages can be related to one other, all of which are attested in the literature. The following discussion of these varieties is loosely based on Pavlenko (1999; see also Pavlenko, 2000, 2005a; Jarvis & Pavlenko, 2008) and Athanasopoulos (2015), though our general perspectives differ enough to make close comparisons difficult.

One extreme possibility is that the same representation is used for both (or all) languages. What this usually amounts to is that a new L2 item is simply given the meaning of its translation equivalent without recognition of differences. Within MCF this is a natural development, at least at early stages of learning. A new PS/SS for the L2 becomes coindexed with whatever CS representation is active at the time, and this will very often be simply the meaning of the L1 translation equivalent. It could be activated by understanding based on context or by presentation of the translation equivalent in the L1 or by explicit definition in either language. One significant qualification on this picture is that new conceptual representations include aspects of the context in which they are constructed. So unless the relevant contextual features exactly match features already associated with the L1 representation, the L2 representation will differ at least slightly.

In some cases, a relatively straightforward L1-L2 equation will be more or less appropriate, with words for numbers or days of the week, for example. Further development, via processing experience, might add language-specific details to the representations, leading to some limited divergence between languages but with the overall meanings remaining virtually identical. In other cases, the equation will be problematic and the meaning assignments highly unstable. An example might be a Mandarin speaker learning the English word 'wear'. Mandarin covers the meaning with two distinct words, 'chuan' and 'dai', the former used for clothing in general and the latter for glasses, hats etc.[7] So if 'wear' is initially assigned the meaning of 'chuan' – that is, the PS/SS of 'wear' is coindexed with the CS of 'chuan' – substantial subsequent changes will be required, changes that are likely to come with further processing experience.

The other extreme possibility is that an L2 item has nothing in common with any L1 items, that at least some representations are fully segregated by language. From an MCF perspective it is doubtful that any meaning representation for the L2 can be entirely separate from meaning representations of the L1. All such representations are ultimately composed of conceptual primitives, which form a finite and presumably limited set. The cases in which a concept is unique to one of the languages are those in which decomposition is needed in order to reveal the commonalities. An example is the Mandarin word 'xuemei', a term commonly used by

7. This is a somewhat simplified account of the semantic relations.

students to refer to a younger or more junior female student at the same institution. The typical English speaker has no such concept, i.e. no CS representation corresponding to that idea. But all English speakers have the concepts of student, female, and younger, the component representations of 'xuemei'. A concept that exists in one language but not the other is still making use of CS representations that are used in the other.

This example also illustrates another case discussed by Pavlenko (1999) and Athanasopoulos (2015), that of new concepts being added for one of the bilingual's languages. An English speaker acquiring Mandarin is likely to add to CS the new concept that constitutes the meaning of 'xuemei'. It will be constructed from existing representations that were activated when the new word was encountered. Again, this new concept is not entirely new, in the sense of having no overlap with existing concepts. Some overlap with representations constituting the meanings of L1 items should be expected. How thoroughly the new concept will match the native concept is also open to question. Subtle connotations that are part of the latter might or might not become incorporated in the former.

Another type of interaction discussed by Pavlenko (1999) and Athanasopoulos (2015) is *shift* in the meaning of L1 items to the meaning of L2 items. This means that the L1 PS/SS becomes coindexed with the CS of an L2 item and this connection wins out, either temporarily or lastingly, over its connection to its original, L1, meaning. Such a shift can occur when the L2 CS representation is active during L1 processing, allowing attachment of its index to the L1 PS/SS. The result will be competition between the two CS representations for use in processing whenever the L1 item is active. The winner in any given case is determined by relative current activation levels, which are subject to several factors. If the L2 CS has acquired a higher resting level due to extensive use and/or to attrition of the L1 CS, it will be at an advantage. If it has received extensive recent use, its current activation level is thereby elevated. If the person is in a context that favors use of the L2, its current level will be elevated as a result of the contextual influences. Finally, if the person values the L2 or this particular L2 item then the item's current activation level will get an affective boost from connections to the value representation in AfS. With any of these factors or a combination of them, the L2 CS could come to be used as the meaning of the L1 item.

We have considered the possibilities that an L2 item will acquire the meaning of an L1 item and that an L1 item will come to have the meaning of an L2 item. An intermediate possibility exists, namely that the two will *converge* toward a meaning that differs from both original meanings. This possibility is created by the most basic nature of processing, including that in CS. When the processor is faced with two active representations, it attempts to construct a new representation that will reconcile them. We considered above cases in which two CS representations are simultaneously active, one of them constituting an L1 meaning and the other an L2 meaning. The CS processor's effort to reconcile them could yield a new representation that is a compromise between them. This representation would then join the competition and possibly become, in the long run, the primary meaning of both items.

In the shift and convergence cases, we see in effect an attrition of L1 concepts. In MCF terms, this attrition could take one of three forms. It could mean that the CS representation is falling in resting activation level due to lack of use. It could mean, instead or in addition, that the resting level of its connection to the PS/SS item is falling because the two are not being used together. It could mean, again instead or in addition, that the index connecting the PS/SS item to a rival L2 CS has become so strong that the old L1 connection cannot compete. It should be possible to test these different possibilities.

Finally, as Athanasopoulos (2015) and others have noted, all these forms of representation can be found in any given speaker and they are likely to undergo substantial change over time as a result of various factors, including increased language proficiency, socialization, and the extent to which the language is used. This, again, is as expected given the MCF framework.

3.4 Metalinguistic knowledge in the bilingual mind

Metalinguistic abilities have been the subject of much debate for a number of decades from various perspectives, notably educational, developmental and processing points of view (Bialystok & Ryan, 1985). This topic is important for bilingual processing because it has long been recognized in the literature that bilinguals excel in metalinguistic ability compared with their monolingual peers (Bialystok & Ryan, 1985; Friesen & Bialystok, 2012; see Adesope, Lavin, Thompson, & Ungerleider, 2010, for a review).

In 3.2 we noted that metalinguistic knowledge is primarily conceptual in nature, which is to say it is centered in CS, where it can serve as a component of internal context. As an example of metalinguistic knowledge, we considered, the concept that adjectives precede nouns in English. Importantly, this concept includes the CS representation ENGLISH. Once this concept exists in CS it can be used to explicitly label any other concept as belonging to one language or the other. This conclusion should in fact be clear from the fact that we are capable of explicitly identifying words as belonging to a particular language; this knowledge consists primarily of CS representations. Importantly, the items that are so labeled are not linguistic items as such but rather abstract concepts of linguistic items; they are metalinguistic.

These 'label' representations take on some significance in the bilingual case, as an ADJECTIVE PRECEDE NOUN representation that is appropriate for a monolingual English speaker would have to be labeled as an English principle in the case of an English-Spanish bilingual, for example. Apart from this point, though, the situation for bilingual metalinguistic knowledge is not fundamentally different than that for monolingual metalinguistic knowledge. The same conceptual representations are available, including of course concepts like WORD, SOUND, and NOUN, and they can be combined in the same ways for a second language as they are for a first. Bilinguals also have the potential to develop what could be called meta-metalinguistic knowledge, using metalinguistic representations of each language to make comparisons and thereby establish representations of the fact that adjective-noun order differs in English and Spanish, for example.

The significance of metalinguistic knowledge, apart from its intellectual interest, lies in its ability to influence linguistic processing. Language comprehension is at its heart a matter of CS activity responding to SS activity, i.e. to the linguistic input as such, but an active metalinguistic representation in CS can interact with this processing to alter the message being constructed, possibly for the better. In production, an active metalinguistic representation in CS can influence AS activity, which can in turn influence the motor activity underlying articulation of an utterance. Articulation typically is, at least in the case of proficient, fluent speech, largely a product of phonological (PS) output. But a highly active metalinguistic representation can act as a competitor with PS influence, or as a modulator. The extent to which it is successful in the competition is the extent to which the utterance is an expression of metalinguistic rather than linguistic knowledge. These factors point to the potential value of explicit metalinguistic knowledge for language use. But caution is required in drawing practical implications from these in-principle considerations. It is a large jump from in-principle possibilities to in-practice benefits, and there is a history of excessive optimism in this regard (see Truscott, 1996, 1998, 2007a, 2007b, 2016). We will return to the nature and use of metalinguistic knowledge in Chapter 11.

4. Sign language

Significant input to the study of bilingual representation comes from a relatively new research area in bilingualism studies, namely sign languages. However, the MCF needs no special adjustments to accommodate explanation of sign language behavior. Schemas are activated using exactly the same set of interconnected modules and processing principles used for the explanation of any other cognitive behavior, and, since language is involved, the core language system naturally plays a pivotal role: we make the safe assumption that sign languages are natural languages like any other and differ only in the mode in which signers produce and understand utterances.

The evidence for acquiring a sign language is framed in visual signals where written text is replaced by a whole variety of hand and body movements as well as facial gestures. Accordingly, a minimal representational chain is activated where the main input to the phonological system comes from the visual system, not the auditory one. The word 'phonology', which is derived from the Greek word for 'voice' (φωνή), is also used in sign language linguistics. The working assumption is that we need posit no special system for signers mediating between gestures and the linguistic modules, in other words do not assume the other possibility, namely that the interface existing between the visual system and auditory system acts as an intermediary for sign language interpretation thus: VS⇔AS⇔PS but rather is a direct link thus: VS⇔PS: the visual system with its visual structures (VS) is recruited by signers as a substitute for the auditory system where, in non-signers, it would be generic sound structures (AS) that would be linked with phonological structures.

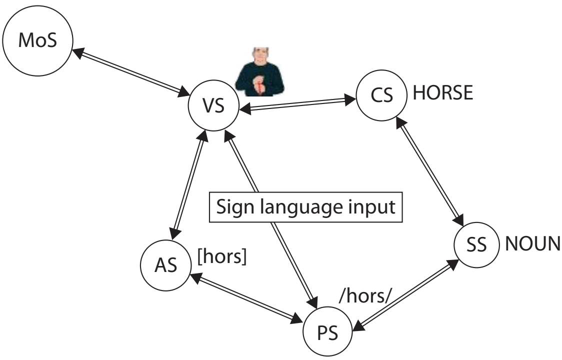

Figure 5.1 A sign language schema (adapted from Sharwood Smith, 2017b, p. 119)

At the same time, users of sign languages may well have varying degrees of hearing ability as well so we can assume in those cases that speech input feeds in directly into the auditory system. This then allows for the possibility of a certain degree of bimodal bilingual development and bimodal performance with signers able also to hear and comprehend words in the local spoken language *at the same time* as they are processing the visual input for the equivalent words in their sign language. In other words, this allows signers to do what no other bilinguals can do namely to process two languages simultaneously (Emmorey, Borinstein, Thompson, & Gollan, 2008). To do this for any length of time with rapid switching is probably even more resource-consuming than the processing demands imposed on professional simultaneous interpreters who need frequent rests to do their job. It also creates the conditions for bimodal code mixing and code switching using the same or similar kinds of representational schema used by speakers of non-sign languages (Emmorey, Petrich, & Gollan, 2012; Sharwood Smith, 2017b, pp. 119–120).

Figure 5.1 shows the kind of schema we are talking about. It includes the motor system as a node in this network since even in interpreting sign language, the motor system will be activated though not as strongly as it would be during sign language production. The same schema is used for both comprehension and production.

5. Relations to existing models of conceptual representation in bilingualism

Several models of bilingual conceptual representation have been presented in the literature (see overviews in Bartolotti & Marian, 2013; de Groot, 2013; Pavlenko, 2009a, 2009b). We briefly review three examples to see how such models might be accommodated with an MCF perspective (for additional models, which we will not discuss here, see Arêas da Luz Fontes & Schwartz, 2010, 2011; Arêas da Luz Fontes, Yeh, & Schwartz, 2010; Degani & Tokowicz, 2010; Dong, Gui, & MacWhinney, 2005; van Hell & de Groot, 1998). We should stress once more that MCF is not intended to replace existing models or theories of bilingual conceptual representation or of anything else. The goal is, rather, to provide a broad framework in which to interpret them, relate them to other areas of research and theory, and to supply more explanatory detail for those aspects that need further elaboration and disambiguation. Alternative explanations can in principle always be accommodated within the framework. At the same time, depending upon the stated or implicit basic assumptions behind the various proposals, they may still prove to be more or less compatible given the modular architecture of the MCF. What follows below will maintain our focus on conceptual representation but other aspects of each model will also be briefly touched upon.

Proposals about the architecture of the mental lexicon and bilingual counterparts have largely emerged proceeding in small steps, gradually building up enough experimental data to make bolder, more comprehensive hypotheses and models, modifying these where necessary as further experiments are carried out. In many cases, the experiments have focused on one type of processing only, comprehension for example, or even more specifically on word recognition within comprehension. In such investigations, questions concerning the development of the lexicon over time are generally left aside. Particular techniques are used to elicit data such as event-related potentials, cross-language mediated priming and eye-tracking. The first model we cover focuses on production and more specifically translation.

One thing that is striking about the various proposals about conceptual representation that have been made in the literature is the assumption they are making about core concepts, especially 'memory' (with subcategories like 'semantic', 'episodic', 'long term', 'short term' and 'working'), 'words' and 'lexical'. Lacking an overarching framework to which researchers can explicitly commit and which would supply an architecture in which such terms are clearly defined, they might choose to rely either on common sense notions and what are actually quite tentative and unelaborated hypotheses about the precise nature of a word or memory or alternatively they might simply select, without argumentation, one or other of the established concepts from the psychological and linguistic literature. Probably many proposals fall somewhere in between these two alternatives. This means that in examining any proposal from the current perspective we have to first see how such terms and concepts could be translated into MCF architecture before testing out the proposals themselves. In doing so it becomes clear in most if not all cases that the models leave many aspects of processing unaccounted for and deliberately so because their aims are limited. Where the models are MCF-compatible, applying the MCF allows smaller scope accounts to be elaborated into more comprehensive accounts that also cover the unexplained aspects. In this way, the MCF fulfils its function as a broad-based theoretical framework.

One characteristic feature we have noticed about many proposals coming from the psychological literature is an underestimation of the multi-systemic nature of language, something which is particularly emphasized in the MCF. In this context, one has to be careful when reading about the many proposals concerning word recognition and production in the literature to understand precisely what the authors mean by the terms 'word' and 'lexical'. As has been discussed already, in the MCF (following Jackendoff), although words can be understood metalinguistically as single units, they can still be defined in various different ways: Here they are defined in phonological, auditory and visual terms, which means that words are in fact best seen as being composed of smaller units. Each of these units is a separate representation housed within a different module, consisting minimally of a PS, an SS and a CS. This means that the processing of a 'word' is the independent processing of different sub-units (for related ideas, see for example, Dijkstra & van Heuven, 1998, 2002). The notion of a lexicon formally defined as a store that is composed of word-size units, is a dubious one. The term 'lemma' can also be confusing since it sometimes means, expressed in MCF terms, the CS element, sometimes the CS plus its associated SS but nothing else and sometimes the canonical ('citation') form of a word.

5.1 The Revised Hierarchical Model (RHM)

An early and influential proposal was the Revised Hierarchical Model (Kroll & Stewart, 1994). The RHM includes the idea that a bilingual has a single, shared conceptual store for both (or all) languages. This translates easily into MCF architecture in that the conceptual store houses all meanings although, as previously discussed, different languages in a bilingual mind may have somewhat different conceptual representations for a given word like 'house' or 'casa'. This means that in the case of translation equivalents, the relevant pair of CS are more likely to exhibit structural overlap rather than complete identity.

The RHM is less easy to integrate with the MCF with respect to the idea of a lexicon because it posits separate 'lexical' stores for each language. By 'lexical', in this context, we must for its MCF equivalent assume minimally the word's phonological structure (PS) as in /haus/ or else this but combined with its syntactic structure (PS+SS) or, when even more fully accounted for, with its auditory structure (AS+PS+SS) and if we include its written form, its corresponding visual structure as well (VS+PS+SS). Therefore, in order to reformulate, in MCF terms, the RHM idea of separate L1 and L2 lexicons, we need to recast the definition of L1 and L2 'lexical items' as separate language-specific chains of association. However, these chains still link representations across stores shared by L1 and L2.

According to the RHM, speed of lexical access as observed in experiments can be explained by different strengths in the connections that link up all three stores involved (L1 and L2 separate lexicons plus the single, shared conceptual store). Less proficient second language learners faced with translating an L2 word, say 'casa' will still have only a weak association between the word form and its meaning in the conceptual store and so will have followed an indirect two-stage route to its meaning by first activating the associated L1 word form ('house') and thereafter the strong L1 connection with its meaning. However, as the learner becomes more proficient, the direct connection between the L2 word form ('casa') and the shared meaning will become progressively stronger obviating the need to take the indirect and therefore slower route via the L1 lexicon. This seemed to explain the reason for different latencies in translation tests observed in bilinguals with different degrees of proficiency (Kroll & Stewart, 1994; Sholl, Sankaranarayanan, & Kroll, 1995).

Strengths of connection translate, in MCF, into the resting levels of the indexes of the representations associated with one another and currently activated in the course of online processing activity and the way this works is fully accounted for in MCF architecture. The general notion of resting levels and their link with frequency of activation is shared across all models albeit with some variation in terminology although the MCF has a particular modular account of how frequency works.

Later the RHM was slightly modified in the light of evidence from experiments involving event-related potentials (ERPs) which suggested that, in more proficient bilinguals, the increasingly redundant L1-L2 lexical connections do not in fact decay as the direct route to the conceptual store becomes stronger. Rather, they are retained by proficient L2 users and employed especially when L2 processing proves challenging (van Hell & Kroll, 2013, p. 153). This model has had a long and successful history but inevitably has its critics.

5.2 The Bilingual Interactive Activation Plus Model (BIA+)

One big issue that fueled debates about the bilingual lexicon until quite recently was the issue of 'selective access'. This relates to what was already implicit in the section on the Revised Hierarchical Model, namely the degree of separation between different language systems in the mind. In the RHM, both languages share one conceptual store and if one can argue that the conceptual representation of a word is the core of what constitutes a lexical item, i.e. however it happens to be manifested, in speech or writing, the RHM comes down on the side of 'non-selective access'. Independent of which language is being used, there is activation of both (or all) languages in a bilingual mind. We will pass over for the moment concerns we have about the hierarchical ideas of 'access' and 'selection', namely that they can lead us into the homunculus fallacy of a single supervisory system (see Chapter 6) and here simply treat them as convenient metaphors. One model, focused on word recognition, that comes down very strongly in favor of non-selective activation is the Bilingual Interactive Activation model and its revised version the BIA+ (Dijkstra & van Heuven, 1998, 2002).[8]

One fundamental feature of the BIA+ model is that it is connectionist. Although the MCF deals in similar concepts, e.g. distinct networks and spreading activation, and could be loosely, and we would argue, misleadingly thought of as connectionist in some sense, nevertheless the MCF has a different and more constrained modular design and is also much more ambitious in what ground it covers. Processing in the MCF is not only incremental, it also runs in parallel and bidirectionally since the framework aims at explanations of both comprehension (as in word recognition) and production processing. It also provides explanations for how knowledge, in the form of representations, develops and attrites over time.

Neither the BIA+ nor the RHM models say anything substantial about development over time apart from the general principle that connection strengths between nodes will change in response to input; in the MCF, the mechanisms underlying

8. For a fuller discussion of various computational models of bilingual comprehension see, for example, Thomas & van Heuven (2009).

both development and online processing are elaborated in detail. Nevertheless, the BIA+ does have features and empirical findings that are (re)interpretable within the MCF. One reason for this is that the BIA+ model is a localist connectionist model in which nodes are symbolic and not subsymbolic and contentless. Localist models, unlike parallel distributed versions of connectionism, either see symbolic representations as single nodes or as patterns of nodes. Furthermore the BIA+ model does have what might be described as a mildly modular character possessed by all localist approaches in that there are different types of representations and subsystems (e.g. orthographic, semantic, phonological subsystems) involved. Input processing in the BIA+ involves a lexical and postlexical stage.

According to the BIA+ model, lexical information from a bilingual's two languages is represented in an integrated lexicon so this means there is initial non-selective activation of language systems. Input is processed separately via four separate lexical systems prior to a language-identifying stage and the ultimate semantic stage. This means that the language-identifying node in the earlier BIA version now only operates in what they call the postlexical stage, that is to say it takes place separately from the lexical orthographical and lexical phonological systems. This complete set of stages (the 'word identification subsystem') leads on to a task/decision system (a type of executive function).

It might appear at first glance that language identification as represented in the BIA+ model has simply been incorporated into the MCF equivalent of the semantic stage of input processing, i.e. the conceptual system. In fact, language identification in the MCF is best seen as the outcome of a collaboration across many modular systems that are activated in parallel. There are certainly language-identifying representations in the (MCF) conceptual system. However, language membership in both perception/comprehension and production processing is expressed more importantly in the triggering of associative networks (i.e. representational schemas). Somewhere along the line, the language identifying conceptual representations will be involved, at least at a subconscious level, but the interaction between language systems is very much a function of general processing principles. This may not even involve any significant activation of linguistic representations that are processed in the 'language-neutral' phonological and syntactic modules although we see these two modules as never entirely inactive in response to visual or auditory input.

For example, the perception of a given isolated visual pattern that corresponds to the orthographic form of a word in Romanian, say 'marul' ('the apple') could in principle trigger a minimal schema that just includes the appropriate visual structure (VS) plus the conceptual representation ROMANIAN. This would at least allow an individual to recognize 'marul' as 'Romanian' without actually knowing anything more about it. Depending on a bilingual's proficiency in Romanian, the schema could also involve the parallel activation of appropriate phonological and syntactic structures as well as a conceptual structure (CS). One CS might represent the meaning of the Romanian word in question ('the apple') and another might even represent metalinguistic knowledge about words ending in 'ul' in Romanian. This modular collaboration allows for the activation of countless possible schemas yielding results such as recognizing 'marul' without knowing its meaning but still identifying it as Romanian or recognizing it as an example of the postnominal definite article 'ul' or identifying 'marul' as conveying the meaning 'apple' but without identifying its internal morphological structure and so on and so forth.

Clearly it is not a straightforward matter to compare models like the BIA+ with theoretical frameworks that have very different aims and scope but it is possible to demonstrate how research from one can feed into or be otherwise related to broader explanations even where there are some important differences in underlying assumptions. As the discussion in the following chapters proceeds, the way MCF architecture handles the kind of processing phenomena that these very focused models are trying to capture with regard to bilingual word recognition will be further elaborated and illustrated.

5.3 The Modified Hierarchical Model (MHM)

In her Modified Hierarchical Model, Pavlenko introduces some changes to the conceptual system to correct the assumption that a shared conceptual system should mean that all languages share the identical concepts (Pavlenko, 2000, 2009a, 2009b). As also pointed out by for example Kroll, van Hell, Tokowicz, & Green (2010), the fact that different languages lexicalize concepts in different ways does invalidate the notion of a fully shared conceptual system. In the MHM (Figure 5.2), apart from separate L1 and L2 lexicons, there is the conceptual system that contains three types of representation, L1-specific categories, L2-specific categories and shared categories (see also Dong, Gui, & MacWhinney, 2005). This

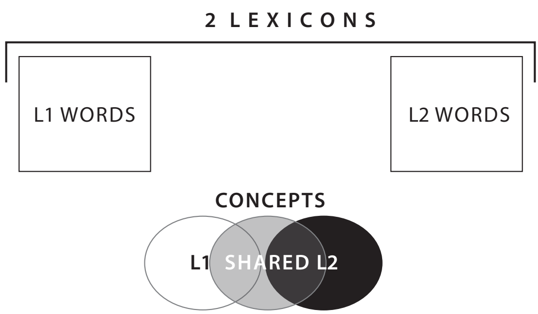

Figure 5.2 Concepts and lexicons in the MHM (adapted from Pavlenko, 2009a)

allows the MHM to formalize various relationships observed in crosslinguistic influence in priming studies between L2 words and L1-specific categories but also between L1 words and L2 specific-categories in terms of interactions between these three systems.

5.4 Areas of consensus and limitations

Overall, models like the small sample selected above that have been constructed on the basis of carefully formulated hypotheses about a particular domain of language processing and successive psycholinguistic experiments generally do support the notions of a shared conceptual system and non-selective access, both of which are basic features of the MCF. There is also a general search for the ways in which activation and inhibition explain the patterns of observable behavior we see in bilinguals. The role of language tags is especially interesting since research shows that they cannot act to suppress the bilingual's current non-target language: This was an important difference between the two versions of the BIA model with the later one adjusted in recognition of this failure of language tags to fully engage selective access. Nevertheless, a model of bilingual processing does have to explain how bilinguals can indeed successfully maintain separation of their languages for effective speech production and comprehension in the current target language, an issue that we will take up shortly (see also discussion of related approaches in Chapter 7, Section 6).

The overall picture suggests that edging forward in careful experimentally-driven steps is a successful research strategy up to a point. However, with so many aspects of processing architecture left undefined or only partially and tentatively defined and indeed perhaps impossible to define on this narrow basis, ultimate success is by no means assured. This strongly suggests a need to integrate discussions of experimental data with one or other of the broader frameworks available; these wide-scope approaches have an account of mental architecture in general and they can be used to elaborate on and contextualize the small-scale explanatory models which have been specifically designed to make sense of data elicited using particular types of experimental techniques. There is always a danger that small-scale models might be developed that neatly explain a particular set of experimental data but are much less plausible when set in the context of the whole spectrum of what we know about mental (and neural) processing in general. Naturally in this particular book we favor the MCF but the principle of contextualizing smaller-scale models within broad-based accounts applies across the board.

6. Conclusion

In this chapter we have covered various aspects of how languages are represented in the bilingual (multilingual) mind and especially how, in the MCF, no extra adjustments or additions to its architecture are required to explain the creation, storage and online use of more than one language system. While the core linguistic systems, when faced with input arising out of exposure to a new language, build new sets of connections using their current repertoire of representations, a central role has to be attributed to the conceptual system when accounting for bilingual processing. It is here where semantic and pragmatic representations that are specific to a new language must be created. It is also here where the knowledge and resulting awareness that bilinguals have concerning their bilingual abilities and bilingual identity is created in the form of metalinguistic knowledge. The chapter concluded with a discussion of existing models of conceptual representation and their relationship with MCF accounts.

CHAPTER 6

Cognitive control and language control

1. Introduction

We now take up the issue, briefly mentioned in previous chapters, of cognitive control, also known as executive function or executive control. Under these various names it has become a hot topic in bilingual language processing (e.g. Abutalebi & Green, 2016; Green & Wei, 2016; Kroll, Christoffels, & Bajo, 2013; Marton, Goral, Campanelli, Yoon, & Obler, 2017; Pliatsikas & Luk, 2016; Schwieter, 2016). The idea, taken from cognitive theory, is that something outside the language processing system itself is exerting an important influence on the system's activity. This is a very important concept, in general and specifically in the study of bilingual processing, where we find frequent appeal made to executive control. Unfortunately, we do not often find clear explication of what exactly it is, particularly regarding its nature as part of the cognitive system. The concept is thus an important target for further theoretical development. In this and the following chapters, we will suggest that the idea of internal context can contribute to such development: Control, as we will call it from now on, can be productively seen as an aspect of internal context. Specifically, for us the study of control is the study of the ways in which inherently internal context influences processing on the stage set by outside-in factors and long-term memory, the latter meaning simply the contents of the various modular stores.

Research on bilingual language control is based on work on cognitive control in general and must be understood as a special case of it, and this is the way we will approach the subject. In this chapter we consider the nature of cognitive control and language control and how outside-in context and the state of the language modules set the stage for the latter, then look at the general fundamental topics of modularity and the heterarchical character of processing in relation to control. In the two following chapters we will more directly consider the relation between control and inherently internal context. Throughout, our focus will be on the cognitive level of explanation, using neural research and theory at a number of points but maintaining a cautious approach to issues of neural explanation.

One important theme of the chapter is that control should not be attributed, explicitly or implicitly, to an unanalyzed agent but rather explained in terms of more fundamental, independently motivated factors. This is the homunculus issue.

But perhaps the most important theme, which we will be exploring throughout the discussion, is the following:

> A theory of control should not be a theory of control. A theory of language control should not be a theory of language control.

In other words we do not hypothesize any special mechanisms for control, by way of contrast with assumptions often voiced in the literature, seeing it instead as a consequence of representation and processing as they are understood in the MCF framework.

2. The homunculus issue

2.1 The problem

When we speak of 'control' it is easy to think in terms of an intelligent agent deliberately directing processing and behavior. It is in fact difficult *not* to think in such terms, given our intuitive understanding of 'control' and of ourselves. This poses a major challenge for theory. When we want to explain seemingly intelligent, deliberate behavior, an explanation that simply appeals to an intelligent, volitional agent that controls behavior is not a meaningful explanation. When a controller is offered as the explanation, we need to clarify its nature and show how this hypothesized nature results in the phenomena of control. If these things are left vague, we are seeking to explain intelligence by saying that an intelligent entity is responsible for it, or to explain control by saying a controlling entity is responsible for it – a non-explanation in both cases (see Figure 6.1). This is the homunculus problem. In casual discussions of cognition, it is common to see control attributed

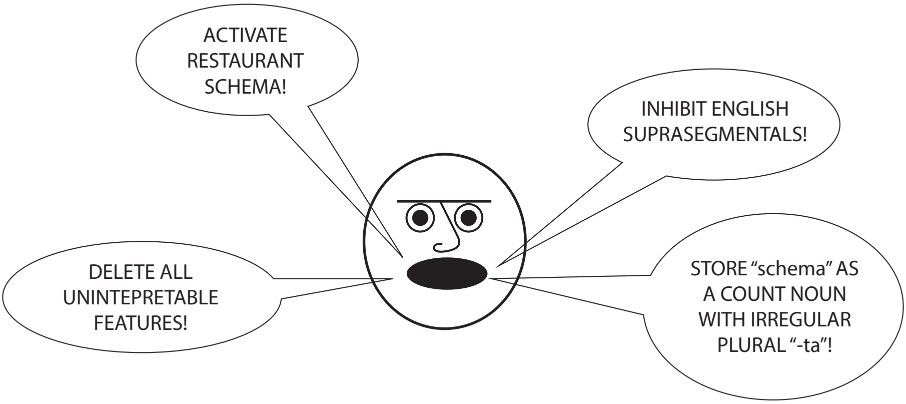

Figure 6.1 The executive controller?

to the person, the speaker, the mind, or the brain, without explanation of what exactly this attribution means. In cognitive theory this role has been filled by a variety of entities, often with questionable development of their nature and the nature of their control. Prominent examples can be found in the literatures on attention, working memory, and language processing.

The intuitive idea of attention is that it is a focusing on one thing rather than others. But considerable caution is required with the concept. The cognitive literature contains a great many differing conceptualizations of attention, with often uncertain relations among them, and a great many different processes are subsumed under the term (see Allport, 1993; Johnston & Dark, 1986; Mack & Rock, 1998; Meyer & Kieras, 1997; Moray, 1969; Parasuraman, 1998; Pashler, 1995). Few authors, in fact, would now say that there is any one thing to which the term 'attention' refers. It is best seen as an "umbrella-term for a general topic, subsuming a host of questions about selective processing" (Driver, Davis, Russell, Turatto, & Freeman, 2001, p. 64).

In the cognitive literature, attention is commonly treated (often implicitly) in terms of control. Discussions of attention routinely speak of allocating, shifting, or focusing attention, for example (see Johnston & Dark, 1986). The implication would seem to be either that an intelligent agent, usually unspecified and unanalyzed, controls attention, or that attention itself is an intelligent agent. Good examples can be found in discussions of consciousness, where we repeatedly see talk of attention selecting the contents of consciousness. Such unanalyzed appeals to attention as a controller make it in effect a homunculus, a problem explicitly addressed by Krauzlis, Bollimunta, Arcizet, and Wang (2014). Thus uses of attention to account for control can easily contribute to the homunculus danger.

The same sort of problem, in a closely related form, has appeared in the working memory literature. Baddeley's (1986, 2007, 2012; Baddeley & Hitch, 1974) *central executive* is perhaps the most important example of a control process in cognitive theory. Its original functions included control of the 'slave' components of the model – the phonological loop and the visuospatial sketchpad – and some general short-term memory storage. It also served as interface between LTM and STM. Its storage and interface functions have since been transferred to a newer component, the episodic buffer, and the control function has been reduced to allocation of attention. But as attention allocator it remains a crucial control system. Baddeley has repeatedly acknowledged, however, that the central executive is in effect a homunculus, in itself offering no genuine explanations of the phenomena (see especially Baddeley, 1996), a theme that has also been pursued by various critics (Jarrold, 2001; Lehto, 1996; May, 2001; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Towse & Houston-Price, 2001). The approach that he has taken to his homunculus is to gradually retire it by assigning its functions to various clearer processes, as this change becomes feasible. The two homunculi, the central executive and attention, are thus intimately associated and similarly problematic.

2.2 Language control and the homunculus problem

The homunculus danger also arises in the area of bilingual language processing, in a variety of ways. In particular, some standard terms in this area can easily be read as assuming intelligent decisions made by some sort of volitional controller. These terms, which might be called pre-theoretical, include 'control', 'access', and 'selection', the latter including the ideas of 'selective', and 'non-selective' access. Each raises the danger of (non-)explanations involving a homunculus.

2.2.1 *'Control' and the homunculus problem*

The term 'control' is itself misleading in that so-called control phenomena involve a variety of *influences* rather than genuine control. It is misleading in another, more important sense as well: It has strong connotations of deliberate action by an intelligent agent. The notion of deliberate action itself requires clarification (of the kind we will offer in Chapter 8), which is not generally provided. Moreover, the nature of the implicit agent is typically vague as well. In other words, use of the word 'control' raises the homunculus problem. It is greatly preferable, we suggest, to move away from such terms, replacing them with descriptions of the multiple factors influencing bilingual processing. Entirely avoiding the term is difficult, though, as it has been so thoroughly institutionalized in the field. So we will not try to entirely avoid it but simply point out the issues and the logic of altering standard terminology and casting the ideas instead in terms of internal context.

2.2.2 *'Access' and the homunculus problem*

The term 'access' appears routinely in the literature on language processing.[1] The thinking behind the term is generally not spelled out, particularly regarding who or what is doing the accessing. Its use readily suggests that an intelligent agent – the person? the mind? the brain? the (conscious) self? – is pulling information out of a store and putting it to use. We thus have a danger of an implicit homunculus playing a central role in the explanation. A better way to think of the issues is to ask the following:

– What are the factors that determine which particular representations end up appearing in production or comprehension?

1. The term has a related use in specifically generative approaches, as in 'UG access'. We address this equally misleading usage elsewhere (Sharwood Smith & Truscott, 2006, 2014b).

– In the bilingual case, what are the factors that determine which representations from which languages end up appearing in production or comprehension?

The answers will describe a very complex process in which a variety of factors contribute to changes in activation levels which in turn determine which items are overtly used. Descriptions of this process that involve an implicit agent are likely to lead to confusion rather than understanding. For this reason we prefer to avoid the term 'access' altogether.

The phenomena commonly described in terms of 'access' do sometimes involve a sense of deliberate choice, or volition. In such cases the volitional aspect is to be explained in terms of the approach we will develop in Chapter 8; i.e. in terms of consistency between the action and the current state of the goal-based self.

2.2.3 *'Selection' and the homunculus problem*

As already mentioned in the introductory chapter, the term 'selection' is similarly problematic. It again suggests an intelligent process, potentially a homunculus, at the head of a hierarchical set of processing events. It thus moves us away from a serious look at the heterarchical processes involved in processing. The same is true for 'language selection'. Instead of saying that a language is being selected, it is preferable to ask how individual representations are winning the competition for inclusion in processing and what implications this process has for phenomena at the higher, language level. This and related terms must be used with due caution, keeping in mind their metaphorical nature and potentially misleading implications.

Two related terms are 'selective' and 'non-selective', as used in regard to 'access'. Their implication, again, would seem to be that some intelligent agent is deciding which items to use and that now we want to know whether this agent is considering candidates from both languages or only from one, pre-selected language. Again, it is better to avoid such concepts and instead explore the various factors that together determine which representations appear in performance in a given case.

2.2.4 *Conclusion*

Thus the use of the controller idea raises the danger of a homunculus being introduced into theories. It is essential to avoid the implicit assumption of an intelligent, unanalyzed agent directing processing. What then does it mean to speak of control? To what extent can the processing system be seen as having two parts, a computational component and a controller? Returning to issues raised earlier, how is such a distinction related to consciousness and the intuitive sense of agency and effort that are (inconsistently) associated with control? We will suggest in this and the following chapters that the idea of internal context, as described above, points to answers to these questions.

3. Control

Cognitive control is a very large topic. Our interest here is in central ideas and findings, particularly in how they can be understood in terms of internal context, a point that we will explicitly address in the following chapters. In the present section we first look at the general nature of control from a cognitive and then a neural perspective.

3.1 The nature of control

Discussion of control processes is inevitably complicated by the lack of a generally accepted definition of control. Goldstein, Naglieri, Princiotta, and Otero (2014) characterized 'executive functions', essentially equivalent to '(executive) control', as an umbrella term covering a large assortment of mechanisms and quoted 30 different definitions for the term. While these definitions vary considerably in their details, a recurring theme in them is *goal-directed* behavior, particularly as it occurs in the absence of automatic processing. *Control is about goals.*

Understood in terms of goals and their execution, control is difficult to separate from a number of other factors. First, a goal exists and is carried out in the context of self. While self is not a standard topic of discussion in the context of goals, it is implicitly present much if not most of the time. Control is often said, or assumed, to be largely or entirely deliberate, an idea that is difficult to make sense of without the assumption of a self. It is sometimes defined in terms of what *we* are trying to do or what *an individual* is trying to do; i.e., a self is assumed. More often, this element is left implicit. Second, goals necessarily involve value. The idea of goals includes the idea that some valued state is not now actual, or that some other state is negatively valued and must be avoided or escaped from. Third, emotion exerts a strong influence on the establishment and execution of goals. It is also inseparable from value. It has generally – but by no means always – been left out of discussions of cognitive control, presumably reflecting the traditional separation between emotion and rational thought, but it clearly belongs in any such discussion. Along with goals, these three factors – self, value, and emotion – are the elements of inherently internal context.

A number of important phenomena are also intimately, if sometimes confusingly, associated with control. One is the sense of effort. Diamond's (2013) review, for example, characterized executive functions as effortful, top-down processes that are needed when automatic processes and intuition are not sufficient or not appropriate. Closely related is the idea of volition. While 'volitional' and 'effortful' are not the same thing – volitional acts can be effortless – the presence of effort does imply that an act is at least temporarily expressing the person's will, even if sometimes in a conflicted way.

Control is also intimately associated with attention; the literature on control is in fact difficult to separate from that on attention. Prominent examples are Baddeley's (2007) conclusion that his central executive is essentially an attention-allocator, Posner's (2012) treatment of executive function as one part of his attention system, and Schneider and Shiffrin's (1977; also Shiffrin & Schneider, 1977) distinction between automatic and controlled processes, the latter but not the former requiring attention. In these and other approaches, attention can be seen either as the tool of executive control or as the controller itself.

This connection between attention and control points to an additional issue in this area: the relation between cognitive control and consciousness. Consciousness and attention are intimately related. Intuitively, the things we are conscious of and the things we are paying attention to seem to be identical or at least nearly so. In cognitive research the close association has generally been taken for granted, but there is also compelling reason to think that the two cannot be equated (see Anderson, 1995; Baars, 1997; Koch & Tsuchiya, 2007, 2012; Lamme, 2003; van Boxtel, Tsuchiya, & Koch, 2010). Consciousness is also strongly associated with our sense of effort and volition. But this connection, like that with attention, is quite imperfect and often confusing. In any case, the involvement of consciousness is a significant topic for the study of cognitive control.

A final connection that deserves note is that between control and working memory. The latter is clearly related to attention, in that the things currently in working memory tend to be the things we are paying attention to. The connection between working memory and control has been a recurring theme in cognitive research. Diamond's (2013) review, for example, lists working memory as one of the three basic executive functions. The original Baddeley and Hitch (1974) model of working memory included a central executive as one of its core components, and it has been pursued in much subsequent work (e.g. Baddeley, 1996, 2007; Katus & Andersen, 2016; Lehto, 1996; May, 2001; Towse & Houston-Price, 2001). Perhaps most importantly, at least for our purposes, the focus in state-based theories of working memory is on activation of representations, this activation amounting to inclusion in WM (see Chapter 2). The activation, however it is characterized, necessarily includes executive processes as sources of activation.

To summarize, control should be understood first and foremost in terms of goals, but with a recognition of the important roles also played by the other inherently internal factors of internal context, namely self, value, and emotion. These are all themes that we will pursue in this and the two following chapters. An adequate understanding of control also requires accounts of its relations with attention, working memory, effort, and consciousness, issues that we will defer until Chapters 10 and 11.

3.2 The neural basis for control

Control is also a prominent topic in cognitive neuroscience (e.g. Banich & Depue, 2015; Cavanagh & Frank, 2014; Domenech & Koechlin, 2015; Fuster, 2015; Goldberg, 2009; Hikosaka, Kim, Yasuda, & Yamamoto, 2014). One issue for this research is identifying control regions in the brain. Another is how these regions exert control over processing in other areas. Processing and control of processing crucially involve synchronization of neural activity within and across regions, so this is also a topic of this section. At this point, research does not provide definitive answers to the major questions, so the discussion here is necessarily tentative. But connections with neural research are an essential issue for an understanding of control, including language control, and their importance will presumably grow as neural research progresses.

3.2.1 *Control regions in the brain*

There is a consensus that control is primarily associated with prefrontal cortex (PFC), though parietal areas such as the intraparietal sulcus (IPS) clearly have a role as well (see below). Regarding PFC, perhaps the most authoritative account is that of Fuster (2015). For Fuster, PFC in general is about goal-directed behavior and thought, which is essentially control. He divides PFC into lateral areas, responsible for what is traditionally called cognitive control, and orbitomedial areas, responsible for emotion and other basic functions. Importantly, both are about control; they are simply different types of control, the former involving 'goals' in the more traditional sense of the word. Orbitomedial PFC is the highest portion of a phylogenetically old system underlying basic functions such as emotions, drives, instincts, and motivation. This system also includes traditional 'limbic' regions, notably the amygdala, as well as medial temporal regions commonly associated with declarative memory, notably including the hippocampus. This ancient system interacts with the newer, lateral system, especially via the anterior cingulate cortex.

Fuster's (2015) distinction between cognitive (lateral) and emotional (medial and orbital) regions parallels that between conceptual structures and affective structures as we described them in previous chapters. These modules cannot simply *be* the two PFC regions, though; each is much more extensive than that. CS must include posterior areas associated with concepts, and probably premotor areas, adjoining PFC, that are involved in relatively high-level planning of movements. A likely analysis is that these additional areas largely correspond to the CS store while lateral PFC is the conceptual processor (see Chapter 5). This view is supported by findings that patients with major damage to lateral PFC suffer greatly in performance of novel tasks but have little or no trouble in relatively familiar ones. Recall that the function of a processor is to combine active representations in its store to produce new ones. If the processor is destroyed, the possibility of novel representations will be eliminated or greatly reduced but already-existing representations will remain, capable of functioning in essentially the ways that they always have. Turning to affective structures, the lower and phylogenetically older system just described appears to be its neural substrate, with orbitomedial PFC its highest level. Further analyzing it into components is quite difficult, though, and we will leave the details open.

A number of authors have described a frontoparietal, or frontoparieto-cingulate attentional network (e.g. Krauzlis, Bollimunta, Arcizet, & Wang, 2014; Miller & Buschman, 2014; Nobre & Mesulam, 2014; Sestieri, Shulman, & Corbetta, 2012), which in effect exercises a control function by influencing relative activation of representations in posterior cortex, representations that are perceptual in a broad sense of the term. In terms of the discussion above, and following the description of Nobre and Mesulam (2014), the (pre-)frontal aspect can be associated with goals, the cingulate with value and emotion, originating at lower levels and being expressed through the cingulate, and the parietal with integration of current perceptual information, with LTM playing a large role in the integration. In other words, the cingulate and prefrontal are about inherently internal context while the parietal is largely about integration of outside-in context. Value and affect also have more direct involvement through their own connections to perceptual representations (Fichtenholtz & LaBar, 2012; Krauzlis, Bollimunta, Arcizet, & Wang, 2014; Pessoa, 2013, 2014). The result of all these influences is that perceptual (and other) processing is shaped by active goal representations and value/affect representations, in the context of relevant long-term memories and current sensory input.

3.2.2 *Local synchronization of processing*

To be effective, processing within a module has to be coherent. This is in fact the function of a processor as we have characterized it in MCF: to make a single coherent representation from whatever representations are currently active in its store. From a neural perspective, this is local synchronization of activity. Relevant research does not yet provide an entirely solid basis for relating the cognitive and neural levels here, but some cautious consideration is feasible.

First, local synchronization in this context refers to synchronization of activity within a module, corresponding at the cognitive level to the establishment of a single representation that is consistent with the principles of the processor. A possible neural indicator of this process is the gamma oscillation. Gamma appears throughout the cortex and is often considered a signature of cognition, particularly local cognition (see Bastos, Vezoli, & Fries, 2015; Herrmann, Munk, & Engel, 2004; Pritchett, Siegle, Deister, & Moore, 2015; Womelsdorf et al., 2007), possibly to be interpreted as cognition within a module. In this role it is commonly seen as modulated by theta oscillations.

Much of the importance of the local synchronization stems from the fact that synchronous neural activity can have a much stronger effect than uncoordinated firing on activity elsewhere (Engel, Fries, & Singer, 2001; Fries, 2005; Salinas & Sejnowski, 2001; Usrey & Reid, 1999; for summary and discussion, see Miller & Buschman, 2014). The implication is that a coherent representation in a module has significant influences on activity in other modules, well beyond that of more diffuse processing. So local synchronization can be interpreted both as the result of control and as the source of control, a point that we will pursue below.

Of particular interest here is that a coherent conceptual representation dominating the conceptual store can have a strong influence on processing elsewhere, notably in the linguistic modules, SS and PS. An active goal representation in CS, within a dominant self representation, triggers activation of other representations in CS that are relevant to its execution. These in turn trigger activation of coindexed representations in other modules, via interfaces. In language processing such representations – the goal and the representations related to it – can shape SS processing and therefore indirectly shape PS processing. These will be important themes in subsequent chapters.

3.2.3 *Global synchronization of processing*

Continuing at the neural level, the synchronization of processing that occurs within a module, possibly in the form of gamma oscillations modulated by theta oscillations, represents one piece of a broader synchronization across modules. A key element is the association of gamma oscillations with interareal communication (Canavier, 2015; Canolty et al., 2006; Fries, 2009; Herrmann, Munk, & Engel, 2004; Kitzbichler, Henson, Smith, Nathan, & Bullmore, 2011; Palva, Monto, Kulashekhar, & Palva, 2010; Pritchett, Siegle, Deister, & Moore, 2015; Womelsdorf et al., 2007). Synchronization of phase within and between two regions of the brain creates a window within which one can influence the other. The influence is facilitated by the additional signal strength resulting from the synchronization within each influencing region, as described above. The system is in effect designed to allow the modules to share information with one another.

Considerable neuroscientific research exists on the nature of long-distance synchronization, though the picture is far from clear at this point (and see Aru et al., 2015, for discussion of methodological issues clouding interpretation of the findings). Gamma oscillations certainly play a part, probably by establishing local synchronization that facilitates more long-range communication, as just described. But lower frequency oscillations are perhaps more important specifically for long-distance communication. Theta oscillations are prominent, especially for their role in modulating local gamma oscillations (Bastos, Vezoli, & Fries, 2015; Colgin & Moser, 2010; Foster, Kaveh, Dastjerdi, Miller, & Parvizi, 2013; Wilson, Varela, & Remondes, 2015). Beta appears less often in the findings but seems to have a role as well (Bastos, Vezoli, & Fries, 2015; Bressler & Richter, 2015; Kitzbichler, Henson, Smith, Nathan, & Bullmore, 2011; Palva, Monto, Kulashekhar, & Palva, 2010). Alpha oscillations have been analyzed as suppression of activity that is not relevant to the current task (Bressler & Richter, 2015; Haegens, Osipova, Oostenveld, & Jensen, 2010; Jokisch & Jensen, 2007; Roux & Uhlhaas, 2014), presumably a significant factor in broad synchronization.

This global synchronization has an enormous influence on processing throughout the system, as it results in particular representations acquiring exceptional activation levels. The synchronization necessarily has a focus (though what this means in neural terms is not entirely clear), as the conscious experience associated with it is of one thing. The item in focus can be either an existing representation, intensely activated, or a novel representation created by the combining of existing, highly active representations. Neurally the two are not fundamentally different, since a representation is not a discrete neural unit but rather a pattern of connections and activations.

In either case, processing tends to converge on a single, unified representation, which as a result has an extremely high activation level. This then is the global working memory (GWM) briefly described in Chapter 2. As noted there, the representation that is the focus of the synchronization (is 'in working memory') becomes the current object of consciousness. The synchronization is in effect picking out the focus of processing quite generally. So how it is brought about is a crucial issue – a control issue.

This synchronization is commonly seen as a product of attention, associated with the fronto-parietal network, which in turn reflects the goals associated with prefrontal cortex, as well as current context (see especially Bressler & Richter, 2015). This view fits with the recurring theme in the consciousness literature that attention determines the contents of consciousness (Baars, 1988; Dehaene & Naccache, 2001; Jackendoff, 1987; Mandler, 1975; Posner, 1994; Prinz, 2012; Schneider & Pimm-Smith, 1997; Umiltà, 1988). We will suggest in Chapter 10 that value and goals are behind attention. Affect, including value, enters through connections of the amygdala to PFC and to posterior regions representing the objects of attention and the contents of consciousness (see Bauer, Paz, & Paré, 2007; Karalis et al., 2016; Peck & Salzman, 2014).

Another significant feature of the synchronization involves schemas. Recall that a schema is a network of representations in different modules that tend to be activated together. The global synchronization is the natural way to form such networks, as it consists of a variety of representations being coactivated together.

The resultant high activation levels increase the likelihood that the network will persist afterward; in other words relatively high resting levels will be present for the individual representations and the indexes connecting them.

Much of this discussion is of course speculative, as the subject is not yet well understood. It constitutes an important research area, for which a framework like MCF can serve as a useful guide, potentially reconciling the cognitive and the neural, especially in the context of language control.

3.3 Control as selective activation

Whatever view one adopts of the mechanisms that comprise cognitive control, or specifically language control, it is best seen as a matter of activation, specifically *relative* activation. Control processes work by creating differences in the current activation levels of representations, the relatively active ones becoming the focus of processing and the relatively inactive ones receding into the background. The contrasting levels can in principle be brought about by stimulation of the relevant representations or inhibition of their potential rivals, or a combination of the two. Further use of these ideas requires first some clarification of the concept of activation, particularly regarding the distinctions between two types of activation and two sources of activation, along with the nature and possible role of inhibition in a cognitive account of control.

3.3.1 *Activation: Cognitive and neural*

The term ‘activation’ has two related but distinct senses. The primary sense, for our purposes, is the cognitive one: The activation level of a representation is its availability for use in processing. The neural sense is closely related but cannot be equated with the cognitive sense. Findings of recent neuroscientific studies suggest that availability (presence in WM) sometimes corresponds not to actual activity in neural circuits but rather to temporary changes in synaptic weights within the circuits (Barak & Tsodyks, 2014; Barak, Tsodyks, & Romo, 2010; Fusi, 2008; LaRocque, Lewis-Peacock, Drysdale, Oberauer, & Postle, 2013; Lewis-Peacock, Drysdale, Oberauer, & Postle, 2012; Mongillo, Barak, & Tsodyks, 2008; for discussion, see D’Esposito & Postle, 2015; Postle, 2015, 2016). In other words, an item that is currently inactive, in the neural sense, can nonetheless be highly available because it has entered a state of heightened readiness to become (neurally) active. This state is naturally included in the cognitive sense of ‘activation’.

These findings provide an essential cautionary note for neural research. When no activity is found in a region during a task, we cannot infer that the region is not actively maintaining information – serving a working memory function.

3.3.2 *Activation: Sensory and executive*

Perhaps the most basic source of activation is sensory input, culminating in perceptual (POpS) representations of various sorts, as described in Chapter 2. Focusing on vision, the ultimate product of visual processing is a VS representation. This representation can greatly influence activity outside the visual system by stimulating representations in other modules, via interfaces. These others include perceptual modules responsible for other modalities (i.e. the other POpS modules) and also higher-level modules, including conceptual, phonological, syntactic, spatial, motor and affective. Activation of their representations in this manner is bottom-up (sensory) activation, an influence of POpS representations on other modules' activity. Executive activation, on the other hand, is activation that comes from non-perceptual sources. These are primarily conceptual, particularly goals and the conceptual self representations, and affective, particularly value but also the various emotions that include it and the affective self that is composed of such elements. Activation of this executive variety is what we are calling control.

3.3.3 *Inhibition and the Veto Hypothesis*

Inhibition has long been a significant topic in the area of cognitive control (e.g. Dell & O'Seaghdha, 1994; Levy & Anderson, 2002; Logan, van Zandt, Verbruggen, & Wagenmakers, 2014; Munakata et al., 2011). In bilingualism important roles have been hypothesized for it, particularly in keeping inappropriate language items or systems from interfering in ongoing processing (e.g. Bobb & Wodniecka, 2013; Green, 1998; Guo, Liu, Misra, & Kroll, 2011; Liu, Liang, Zhang, Lu, & Chen, 2017; Misra, Guo, Bobb, & Kroll, 2012). At the neural level the existence and importance of inhibitory mechanisms is clear (e.g. Banich & Depue, 2015; Fuster, 2015; Stuphorn, 2015; Wiecki & Frank, 2013). One indication of their ubiquity is that the most common neurotransmitter in the central nervous system, GABA, serves inhibitory mechanisms. This does not necessarily mean, though, that explanations at the cognitive level – our main concern – require such mechanisms. This is an open question for theoretical development.

We are particularly interested in the question of inhibition as it occurs in conceptual structures, as it is here that control of language is centered. Our past discussions of inhibition (Sharwood Smith & Truscott, 2014b) were very tentative, leaving open the question of whether inhibitory mechanisms have to be hypothesized in cognitive (as opposed to neural) accounts and, if so, what form such mechanisms should take. We will continue with this somewhat agnostic approach here but also consider in more depth exactly what is involved.

The most straightforward approach to inhibition would be to hypothesize a mechanism by which activation levels are selectively *lowered*, as a complement to the mechanism of raising the levels. We might reasonably see such a mechanism as a tool that the processor can use to carry out its one function – constructing a single coherent representation from whatever representations are currently active in its store. On this view, the processor lowers the current activation level of a representation when doing so is necessary for carrying out this function. The logic of such a proposal is that the essence of control is not simply activation level but rather *relative* activation level, as more active representations are more available to their processor than less active ones. So a process that lowers the level of some representations would be useful for control as it makes some other representations available even if their own level is only moderately elevated.

On the other hand, such a mechanism would add a significant complication to the framework, for which parsimony has always been a major concern. Moreover, it is not clear that an activation-lowering mechanism is needed. It may be possible to explain inhibition phenomena, at least as they occur in CS, without this complication.

In regard to overt action, inhibition can be readily explained without any lowering of activation levels. We simply need to hypothesize that the modules controlling actions contain representations amounting to 'don't do it'. There should then be no need for an additional mechanism. When these *veto* representations[2] are sufficiently activated, they are combined with whatever action representation is also active, in effect yielding a veto on that action. One advantage of this approach is that it seems to fit well with common experience, which indicates that deliberately blocking a possible action need not reduce the activation of the *concept* of doing it. The thought of eating the cheesecake may in fact grow stronger with every successful attempt to avoid acting on it. Such observations strongly suggest that inhibition of action is not a matter of lowering activation levels in CS but rather a form of active veto. The hypothesis of a counterpart 'don't do it' representation in motor structures is more difficult to assess but does not appear to raise any obvious problems.

Importantly, this Veto Hypothesis does not involve any new entity, so hypothesizing veto representations in CS as an alternative to inhibition mechanisms is not a matter of replacing one complication with another. The veto representation is simply a conceptual representation like any other, one that is independently motivated by the fact that we clearly do have the concept, explicit or otherwise, of refraining from carrying out an action. Its role in processing can be illustrated by a return to the cheesecake example. Activation of a cheesecake representation

2. It might be necessary to distinguish this veto representation from the meaning of the English word 'veto', which is represented as VETO. We might then call it *VETO*, paralleling the notation *SEEK* introduced in Chapter 4. The MCF is a developing framework and there will and should continue to be modifications and refinements.

results in activation of a variety of related representations, related by virtue of sharing component representations. These are likely to include some that involve negative associations of eating cheesecake, such as goals of losing weight and saving money. Their activation leads to activation or establishment of the specific goal of not ordering the cheesecake, i.e. the combination of the plan to order it with a veto representation. This new, negative goal representation will then compete with the cheesecake-ordering goal representation for influence in CS and indirectly in MoS, the winner determined as always by relative activation level. Thus there is reason to believe that the Veto Hypothesis can explain inhibition of actions, without an activation-lowering mechanism.

There is also reason to doubt the existence of such mechanisms for thoughts themselves, even in the absence of any potential action. Deciding not to think of something is notoriously difficult ("Don't think of elephants now!"). Deliberately lowering the current activation level of a representation seems to be at best extremely difficult and probably impossible, at least under any ordinary conditions. The way to avoid thinking of something is not to suppress it but rather to think of something else, i.e. to raise the current activation level of other representations to the point where they can win the competition over the one that is to be avoided. These observations do not rule out the possibility that there exist special automatic processes that lower activation levels under particular conditions. But they do indicate that an approach which does without them is at least worth pursuing, especially in view of parsimony considerations.

Another aspect of inhibition is the management of distractors during the execution of a task. It is clear that completion of a task often requires processors to disregard some irrelevant, potentially distracting representations within their module. Again, the question is whether this requires an active suppression mechanism, lowering activation levels, or can be a consequence of positive competition in processing. A task is in essence the execution of a goal, and so a goal representation, probably including a number of subgoals, must be consistently active in CS during the task. Other CS representations become active because they are associated with (share component representations with) this goal representation. Carrying out the task means appropriately combining these relevant representations with the goal. This is, in other words, a processor doing what it always does, combining active representations in its store to make a single legitimate representation. When a representation that is not consistent with the goal representation is active in CS, the processor cannot deal with both it and the ongoing task; the result is competition between the two.

If the distractor is sufficiently active it will become the focus of processing, blocking the ongoing task, at least temporarily. If it is not sufficiently active, the representations that are part of the task will win the competition and the task will go on, possibly in a less efficient manner. In this case the distractor is no longer part of the processing and so its current activation level will spontaneously begin to fall (barring outside stimulation). The success of the task-related representations is a form of control, as it means that the goal representation is continuing to guide processing. Its activation level might receive a boost in this context from other goal activity, notably from a 'stay on task' representation. Such representations certainly exist, with differing resting levels for different individuals and in different contexts, depending in part on how highly this goal is valued (i.e. the resting activation level of the index connecting it with value representations).

The question is then whether this provides an adequate account of inhibition phenomena. An inhibition mechanism could in principle enter in two ways. First, the distractor might lose the competition because the processor actively suppresses it, possibly based on a stay-on-task goal. Second, active inhibition might occur after the competition has been decided in favor of the goal-based representations. This would mean that the gradual spontaneous decline in the distractor's activation level is not sufficient, that without active suppression it would remain active enough to continue to exert a harmful effect on the task.

While these questions are relevant to our concerns, answers are not essential and so we will remain agnostic for the time being. We will, however, tentatively maintain the Veto Hypothesis, that inhibition often amounts to a veto on execution of an active plan.

3.4 Cognitive control and bilingual processing

In this chapter we have identified a few common themes in accounts of cognitive control along with some issues that arise in their study. Control is best seen as goal-directed and inseparable from value, emotion, and self. It is associated, but in rather uncertain ways, with attention, working memory, effort, and consciousness. An account of control, in bilingual processing and beyond, should fit these aspects together and at the same time deal with the danger of homuncular (non) explanations. We will suggest in this and the following chapters that the concept of internal context offers a way to achieve these ends.

One issue that inevitably arises in such a study is what exactly the term 'control' means. As noted above, this and related terms have no standard definition in cognitive psychology; a great many related but distinct definitions exist. The lack of clarity probably becomes even greater when the terms are applied to bilingualism. In most writing on the subject control seems to be (implicitly) treated simply as whatever is being measured in the various experimental paradigms in common use. This is not to question the value, or the necessity, of such empirical research, but it is doubtful that genuine understanding of control can be achieved without a much greater concern with what exactly control is. The solution, we suggest, is adoption of a framework that places it in the context of the cognitive system. Ideally, the meaning of control comes from a spelling out of the implications of such a framework.

The way it is spelled out in the MCF, to be described in this and the two following chapters, is simply this: Control is the influence of inherently internal context operating on the stage set by outside-in context. Applied specifically to language control, the focus of this influence is CS activity because this activity is the main influence on the specifically linguistic processing that is carried out in SS and PS. This approach yields a relatively broad notion of control, including both deliberate and automatic varieties. Many might prefer to restrict the term to the deliberate variety. In MCF this important contrast is captured in the notions of self-based and selfless control, which we will develop in Chapter 8. Both are reasonably seen as control in that both constitute outside influences on linguistic processing. While control could be defined as deliberate, self-based processing, such a definition would be missing the fact that goals, value, and emotion exert a constant, crucial influence on linguistic processing, whether that processing is deliberate or not. We can also question whether a clear cut distinction exists between deliberate and non-deliberate processing; the two might be better seen as ends of a continuum. Thus it is preferable, we suggest, to adopt the broader usage and then distinguish deliberate and automatic within this broad notion.

The MCF notion of language control may be broader than that in common usage in another respect as well, as it can be applied to dialect and register distinctions in addition to language distinctions. Vagueness in common usage makes it difficult, though, to judge whether this application is consistent with standard ideas. Such questions can also be obscured by the usual focus on control as it occurs within specific experimental paradigms. In the bilingualism literature, control is typically about selecting which language to use: for an entire discourse, for a particular utterance, and perhaps for individual items within an utterance. Questions about how this occurs do naturally extend to dialect and register distinctions, and indeed to contextual factors of all sorts. Formality of a given context, for example, results in the use of particular linguistic items rather than others – items are selected that are appropriate for the situation. This would seem to be the same sort of phenomenon as selection of the language to be used. The MCF notion of language control as all external influences on language processing naturally encompasses these factors.

4. Setting the stage for control

Control is about selective activation, making some representations more active than others. The ultimate sources of this activation, we suggest, are the elements of inherently internal context. They act on the linguistic modules, some directly from CS and others indirectly *via* CS, influencing the activation levels of linguistic items and thereby influencing linguistic processing. Activity in CS is thus crucial. Since current activity in CS constitutes the heart of outside-in context, we can say that outside-in context sets the stage for control. We can also speak of the stage within the linguistic modules, involving the existing representations there plus the current activation levels of those representations and the relations among them.

4.1 Outside-in context as the stage for control

Control, as we have characterized it and as it is normally characterized in the literature, is a top-down phenomenon. The factors of inherently internal context underlie it, producing differences in activation levels throughout the system and so in effect selecting particular representations for use in processing. But the importance of bottom-up factors in activation must also be recognized. By 'bottom-up' activation we mean that which comes from the senses, i.e. more or less directly from perceptual representations. As a source of activation, this bottom-up influence might be seen as a form of control. We prefer however to restrict the term 'control' to the more internal, top-down varieties, a definition that more closely relates to standard usage. But while bottom-up activation is not in itself what we would call control, it nonetheless plays an important role in control phenomena, as it affects activation levels throughout the system. Most importantly for present purposes, this is about establishing outside-in context, as it was described in Chapter 3. This type of context sets the stage for the control processes. We will first consider here cognitive control in general and then turn specifically to language control.

4.1.1 *Outside-in context and cognitive control*

The establishment of outside-in context begins with activity in the perceptual modules, yielding representations in the individual perceptual output modules and culminating in the global synchronization that presents a unified picture of the world to the cognitive system as a whole. The synchronization gives the participating representations extremely high current activation levels, with the result that they will inevitably have strong influences on processing throughout the system. For our purposes the focus is their influence on conceptual structures. Perception of a particular known person, for example, activates stored conceptual representations of the person and information about him/her, including such factors as language ability. These active representations are then part of the internal context for processing in CS and beyond, notably in the linguistic modules. They serve in effect as guides in subsequent communication with the person. This description of the process is simplified in that there can be no pure bottom-up establishment of internal context; non-perceptual factors are involved in the POpS synchronization, as well as in the processing within the individual perceptual modules and in such basic processes as control of eye movements that determine what images will be made available to the visual faculty.

When a cheesecake is perceived, for example, the sight and perhaps smell trigger construction/activation of visual and perhaps olfactory representations. Their activity will activate conceptual representations of cheesecakes (recall the idea of a semantic hub linking the various modality-specific representations), which in turn activates value and emotion that are associated with those representations – and the goal of eating it. But activation of the goal depends on outside-in context and already-existing representations. If the person is with a group that routinely meets at the coffee shop and has cheesecake there, these factors form part of the internal context, activated in part by perceptual input. Representations of this context are likely to contribute to the activation of the goal representation. This again is bottom-up, perceptual activation interacting with the current state of the system (LTM and current activation levels) and with the inherently internal elements of internal context. Other outside-in context could have the opposite influence. A companion saying “What about that diet you were going to start?” could activate other goal representations that conflict with the eating goal, creating competition for dominance of the goal-based self and therefore of behavior. Similarly, if the person is not hungry or is sick,[3] these contextual factors are likely to alter the value associated with the act of eating the cheesecake, thereby influencing behavior.

Figure 6.2 shows, in simplified form, the kinds of interconnected representational structures that would be active in the cheesecake example. The *SEEK* representation is activated in the conceptual system. Affective values associated with various conceptual and perceptual properties of cheesecakes as well as with the goal to avoid unhealthy food cause the conflicting goals to compete with one another. One can imagine that in one case the positive aspects of the cheesecake will be more strongly activated than the negative and the person will then seek the cheesecake while in another the reverse will be true, allowing the individual to veto the goal of seeking the desired food.

3. While the term ‘outside-in context’ is odd as a description of bodily states such as hunger and sickness, it does bring out an important analogy: The bodily states register in AfS and then in CS (*interoception*) and contribute to internal context in essentially the same way that states external to the body do (perception). We will not pursue this topic further here.

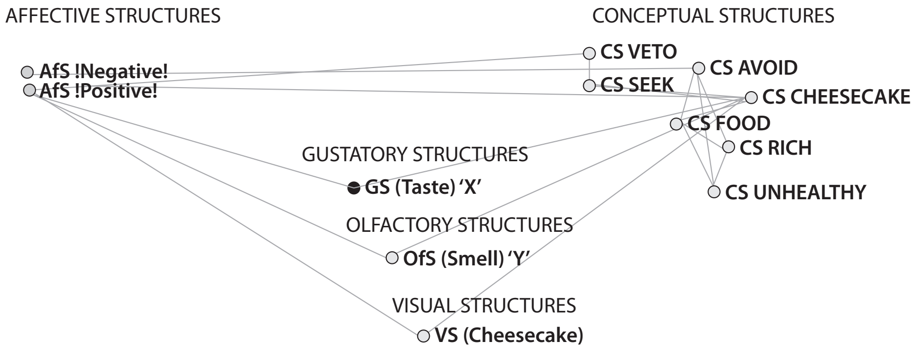

Figure 6.2 Some structures involved in the choice of eating or avoiding a cheesecake

Again, outside-in context does not qualify as control in itself (unless perhaps one is a Behaviorist), but it is an essential factor in the operation of control. It sets the stage on which inherently internal factors operate in their role as controllers.

4.1.2 *Outside-in context and language control*

CS is the stage for the operation of inherently internal context, and this stage is set by outside-in context. The stage-setting is essentially perception, in its broad sense, encompassing both sensory activity and subsequent conceptual representation, which is necessarily based on existing knowledge. Perception is, uncontroversially, an interaction of current sensory experience with background knowledge. In our terms, active representations in the various perceptual output modules activate coindexed representations in CS and the CS processor then seeks to make a coherent representation from these active representations. The result is an internal representation of the external context.

A crucial part of such representation is the presence and identity of other people. Perception of a known person, for example, involves activation of whatever conceptual representations already exist of that person, including whatever information is known (or believed) about him/her. Anything saliently novel about this experience with the person will result in construction of new representations that include the old as components. Perception of an unknown person leads to construction of a representation specifically of that person, based on all active representations in CS, including those directly activated by sensory input and others constituting background knowledge of people.

These outside-in representations often provide the context for instances of language use, and thereby become associated with particular linguistic representations. This is to say that particular words, expressions, registers and so on are typically used in certain contexts and not in others. Thus, these particular contextual representations will be active in CS at the same time that the particular linguistic items are active, the latter including their core CS components, i.e. their meanings. The result is that new composite CS representations will be formed by combining the contextual representations with the CSs of particular linguistic representations. In future processing, activation of the contextual representations will then lead to activation of these associated linguistic representations. The particular linguistic items that are activated at any given point are thus determined in part by the current outside-in context.

Applying these ideas now to bilingual processing, some contextual representations in the conceptual module are associated with one language as a result of previous processing experience, others with the other language. This again is Complementarity (Grosjean, 2010, 2016). If the current outside-in context in CS is dominated by representations associated with one language, then that language is especially likely to be used in the current instance of production. CS representations of the home environment activate linguistic representations of the language normally used at home; those of the work or school environment activate representations of the language commonly used in those environments. Active representations of a person with whom one of the languages is normally used activate representations of that language.

This makes CS center stage for the operation of internal context. In addition to the representations that are the meanings of linguistic expressions, it also contains representations that are crucial elements of inherently internal context, namely goals and self, and of course representations of outside-in context. Because of this crossroads status of CS, activation within the module will naturally be the focus of the discussion here.

4.2 The stage within the linguistic modules

Features of the language system itself can have a strong influence on which representations from which language are used at a given time. This is not control, since control is defined as influences from outside the linguistic system, but it is nonetheless of great importance for control phenomena. The state of the two linguistic modules at any given point can be seen as the *linguistic* stage on which control operates.

4.2.1 *The state of the linguistic modules*

This linguistic stage includes, again, the representations that are present in SS and PS, plus their activation levels and the relations among them. For the bilingual case, the set of representations will include items from both languages, their nature and extent varying greatly with the individual and especially with the extent to which the person is a balanced bilingual. One important variable is the activation levels, both resting and current, of these linguistic representations, as these levels determine which representations will be included in current processing. As we described it in Chapter 2, when a representation has a high resting level this in effect gives it a head start in the competition. Its current level is then the combination of this starting position with recent use or non-use, because a recently used representation will maintain some lingering, but gradually declining, activation as a result of this use. Current level is thus immediate availability – a relatively active representation is on-stage – while resting level is more stable and serves as a crucial determinant of current level.

The role of activation level, resting and current, is depicted in Figure 6.3. In the competition between representations A and B for inclusion in processing, their current levels directly determine the winner, which is B in this case. The resting levels are the points at which each representation enters the competition. Here, the contrast in resting levels gives B an initial advantage, contributing to its ultimate success.

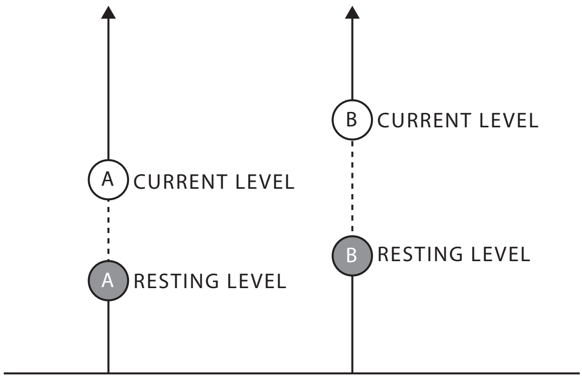

Figure 6.3 Competition based on activation levels

No less important than activation level is the way that different representations are related to one another. These relations are a matter of overlapping features, within each linguistic module and in CS representations that are coindexed with them. Two SS representations can share, for example, component representations such as 'noun' or 'feminine' or 'transitive'. Similarly, they can both be coindexed with a single CS representation, or with two overlapping CS representations, establishing a more indirect relation between them.

Another form of connection among linguistic representations is what can be loosely called 'subcategorization frames'. These in effect serve as frames for the construction of utterances. Their development accounts for phenomena of collocation and subcategorization; in conjunction with coindexed CS and PS representations, they can be called 'chunks' or 'constructions'. Sharwood Smith and

Truscott (2014b, Chapter 4) described in some detail how such frames naturally form within SS, as well as PS and CS. One important feature of the frames is that representations from the same language tend to appear in the same frames, simply because input strings are typically in one language or the other.

The implication of this latter point is that activation of one representation from a particular language will result in activation of frames that include it, and therefore of other representations included in that frame, which are very likely to be from the same language. The frames thus introduce a significant bias in processing: Inclusion of one or more representations from a particular language encourages the inclusion of additional representations from that language. This factor goes some way toward explaining why each instance of language production tends to stick to one of the bilingual's languages rather than randomly mixing the two. But of course it does not explain *which* of the languages is used in a given case or the fact that mixing does in fact occur. For these we must turn to control, in the form of internal context.

4.2.2 *Crosslinguistic activation: Items from both languages are on-stage*

The strictly linguistic stage for language control is set by the factors just considered. The essential next question is whether the stage is restricted to one language at a time or includes, at any given point, representations from both languages. In more familiar terms this is the issue of whether 'access' is 'selective' (only one language is on-stage) or 'non-selective' (both languages are on-stage simultaneously).

The evidence that items from different languages are routinely coactivated during processing is compelling (for reviews, see Brysbaert & Duyck, 2010; de Groot & Starreveld, 2015; Kroll, Bobb, & Wodniecka, 2006; Kroll, Gullifer, McClain, Rossi, & Martín, 2015; Meuter, 2009; Schwartz, 2015). As a result, most authors now accept the non-selective view, typically noting also that crosslinguistic influences are variable and that the factors involved are only partly understood, constituting a crucial area for further research. A variant on this view is that these factors can make processing either selective or non-selective in any given situation (Grosjean & Li, 2013). From our perspective what it amounts to in either case is that representations from the different languages are routinely coactivated during processing and the extent, nature, and effects of the coactivation depend on a number of factors.

Research thus indicates that representations from both languages can be, and routinely are, on-stage at the same time. This finding is expected given the MCF framework. Coactivation of representations from the two languages should be possible at all levels, including PS, SS, and CS, as the system includes only a single PS, a single SS, a single CS, and so forth. Thus, the syntactic representations that are associated with one of the bilingual's languages are found in the same store as those associated with the other language and are manipulated by the same processor. The same is true for phonological and semantic (conceptual) representations. In other words, the two languages should be routinely coactivated during processing. The interesting issues lie in the details of how the coactivation is brought about and exactly what effects it has under different conditions.

The potential for coactivation of linguistic representations is realized in two ways. The first is spreading activation within a store, via shared features (where a feature is simply a component representation). To the extent that representations from different languages share features, this will result in cross-language activation. It can occur at each linguistic level – PS and SS – and at CS, as well. The other source of cross-language activation is cross-module influences. An active CS representation activates whatever SS representations it is coindexed with, for instance, and these frequently include items from both languages. If a speaker knows both L1 and L2 words for 'horse', for example, the CS HORSE will be coindexed with SS-PS items in both languages and so its activation will naturally result in activation of both chains. Thus the sight of a horse, producing an active perceptual (POpS) representation, results in activation of HORSE in CS and then of linguistic chains in both languages. Similarly, activation of either SS representation will result in activation of the other, via the shared CS and any syntactic features that they share.

Thus, the purely linguistic stage for language control routinely includes representations from each of the bilingual's languages. Control is then the external influence (external to the linguistic modules, that is) on which of these representations, from which language, are used at any given point. Whether a representation reaches or approaches center stage, or remains on the periphery while others occupy that position, is a matter of relative activation level. This in turn is determined by a variety of factors, most or all of which can be understood in terms of internal context, as we will show in the following chapters.

5. Cognitive control and modularity

In a modular system, processing is carried out primarily within individual modules, but the activity within a given module is necessarily influenced by activity elsewhere. Given the modularity assumption, this is the natural way to approach issues of control – to ask how the inner workings of individual modules are influenced by factors outside the module. It should be kept in mind that this does not mean the actual transfer of information between stores: This can never occur since representations in different stores are written in different, mutually incompatible codes. What it does mean is that activation spreads, via interfaces, from representations in one module to coindexed representations in another. We will not speak of control processes *within* a module, because these would be inherent parts of the module's operation, not external controls guiding that operation.

This approach raises two possibilities for the source of executive control. First, we could attribute the control function to central, non-modular systems, i.e. hypothesize a hybrid cognitive system consisting of modules and domain-general systems operating on them. As will have become clear by now, though, we favor the other alternative, to pursue the logic of the modularity assumption as far as possible, exploring the idea that the mind is entirely modular. This means hypothesizing that the external controls on a module's activity come from other modules. In terms of bilingual language processing, there is no single control center overseeing language use but rather a variety of elements within a variety of modules.

6. Control: Hierarchical vs. heterarchical

The idea of executive control suggests a hierarchical organization, in which a controller sits above the various processing units, directing their work, and this seems to be the default assumption in many models of bilingual processing. But a modular framework like MCF points to a different interpretation of control. In this approach the mind consists of specialist modules, each performing its own function more or less independently of the others. Such an approach naturally, if not necessarily, suggests a *heterarchical* system (McCulloch, 1945, 1988; see also Section 4 of Chapter 1 above), in which control of processing is diffuse, coming from the activities of the individual modules, in contrast to a hierarchical system, in which a general purpose controller manages the workings of the system as a whole. Within our framework, control is entirely a product of the workings of modules, with no special provisions for control as such.

Two of the modules, the conceptual and affective systems, might be seen as controllers in that they are largely responsible for the phenomena normally classified under control. But they are not control mechanisms as such; they are modules, not fundamentally different from others. They have the same basic architecture and the same sorts of between-module connections and they follow the same general processing principles, with the domain-based specialization that characterizes all modules. Furthermore, it is not the module as a whole that exerts a control function but rather individual representations within it. Perhaps most importantly, the control they exert is nothing more than normal processing as it is understood within the framework.

An account of control must deal with the often deliberate character of much control, which again seems on the surface to suggest an executive guiding the system's performance from atop the system – and in a sense outside it. Even if this deliberate character is seen as an illusion, there should be an account of why some things *seem* to be volitional and others do not. Within our framework self representations in CS, specifically the goal-based self, provide this explanation, which we will develop in general and for the case of bilingualism in Chapter 8. We stress again that self as we hypothesize it is simply a representation, not fundamentally different from any other representation.

An important aspect of the heterarchical understanding of control is that the various factors comprising control can also be said to control one another. As goals are by nature valued, value helps to determine their activation. An active goal can in turn make a given representation more highly valued, or less, depending on how it relates to that goal. Emotion is based on value and tends to be tied to goals, influencing and being influenced by them. Goals make up the goal-based self and so can be considered controllers of it, but they are also shaped and controlled by it. The same can be said for the AfS self and its components. And each self representation of course interacts intimately with value. Note that this heterarchy among controllers fits well with neural understandings of control, as described above.

To summarize, in our approach the mind is largely heterarchical rather than hierarchical, consisting of a number of functionally distinct modules. Each works on its own principles and each influences others simply by virtue of its own processing and the connections between its representations and those in other modules, via interfaces. Control phenomena are to be analyzed as a product of this ordinary processing, particularly in its goal-oriented aspects.

7. Conclusion

In this chapter we established the background for an account of language control in terms of internal context, discussing the nature of cognitive and language control along with several issues that must be addressed in accounting for control phenomena. Prominent among these issues are the danger of homuncular (non-)explanations, modularity, heterarchy, and the role of outside-in context in setting the stage for control. In the following chapters we will turn specifically to the possibilities of explaining control in terms of internal context, taking the points established in this chapter as guidelines. Chapter 7 looks at the inherently internal factors of goals, value, and emotion, while Chapter 8 explores the role of the remaining factor, self. In each case outside-in context sets the stage for the influence of inherently internal context.

CHAPTER 7

Control as inherently internal context

Part I. Goals, value, and emotion as controllers

1. Introduction

Cognitive control can be understood in terms of internal context. As described in the previous chapter, control is about the selective activation of representations, which as a result of this activation will then be the objects of current processing. We have defined the internal context of processing as the set of representations that are not directly part of that processing but are active and thereby exert an influence on it – by selectively activating the representations that *will* participate in the processing. The parallel is strong enough that control and internal context might even be equated. But in fact internal context is a broader concept than control, at least as the latter is normally understood. Cognitive control in its standard sense – the executive variety – is associated specifically with the *inherent* elements of internal context: goals, value, emotion, and especially self. Internal context is the activity of these representations, but it is also activity of representations of the external context; i.e., it also includes outside-in context.

In a traditional Behaviorist approach, bottom-up (external) context would fill the role of controller and any inherently internal factors would be disregarded. The Cognitive Revolution was in essence a recognition that this external focus is not adequate. We thus have now a focus on the inherently internal influences on processing and behavior, and this is very much the idea of cognitive control. The external context certainly exhibits a strong influence on processing and behavior, and this influence could be treated as a form of control, but such a treatment would not reflect standard usage or thinking. The importance of the external factors must of course be recognized, because they influence the current operation of the inherently internal factors and, in the longer term, shape them. But we will use the term 'control' to refer specifically to the influence of inherently internal context.

In Chapter 4, we described two locales for the elements of inherently internal context: (1) affective structures (AfS) for the more fundamental, primitive types – particularly value and emotion – and (2) CS for more sophisticated goals, including goals in the ordinary language sense. Each locale includes self representations constituting relatively coherent and relatively stable combinations of the basic elements in its store. The two general sources of control parallel Fuster's (2015) division of prefrontal cortex, described above, into regions involved in cognitive control of action – the lateral portions – and those involved in emotional control of action – medial and orbital portions. Importantly, each aspect of inherently internal context is also an underlying factor in control, taken as the top-down influence on processing.

Thus language control, as one form of cognitive control, is best understood as the influence of inherently internal context. This influence is played out on the stage set by outside-in context and the state of the linguistic modules. In other terms, *a theory of language control should not be a theory of language control but rather a spelling out of the implications of a general understanding of representation and processing within a specified cognitive architecture*.

In this and the following chapter we develop this point. The focus in this chapter will be on the control function of goals, value, and emotion and how this account of control relates to existing accounts. In Chapter 8 we then examine, in somewhat greater detail, the crucial role of self as controller. Chapter 9 will then apply this account to a range of topics in bilingual processing, centered on coactivation of representations from different languages. We will defer until Chapters 10 and 11 discussion of the point raised in the previous chapter that an account of control should show how it is related to attention, working memory, effort, and consciousness.

2. Goals as controllers

Goals, whether explicit or implicit, general or specific, guide virtually everything we do. So it is natural, even obligatory, to focus on them in efforts to understand cognitive control. In the domain of language use, speaking in one particular language rather than another usually, if not always, serves a goal or goals, as does sticking to that language, as does switching to another language at appropriate times. So goals should be seen as an essential part of an account of *language* control. In this section we will first consider the general control function of goals and then turn to their role specifically in language control.

2.1 Goals as cognitive controllers

We defined a goal as a conceptual representation of a state and the intention to seek it. More precisely, it is a complex CS representation including a state representation and *SEEK*. Goals can range from the very high-level and long-term to the very specific, leading to low-level actions. All types influence behavior by altering processing, often quite broadly, through selective activation of representations.

Activation of particular goal representations leads to activation of additional representations, in various modules, that are associated with those goals. This activation then results in the use of those representations in processing, at the expense of others not related to the goals.

Goals are activated in the same way as any other representation. The sight and smell of a delicious cheesecake is the activation/construction of perceptual representations. These will activate conceptual representations of cheesecakes that are coindexed with them, which will in turn activate any goal representations that include them as components. If no such representations yet exist, the presence of an active cheesecake representation, with high value, might result in the construction of one. Activation of the cheesecake representation might also come from talk of cheesecakes. Thus a person's active goals vary with external context. It should be remembered, though, that the influence is not from external events in themselves but rather from the mental representation of those events – the internal context. And the activation can come instead from activation of memories that include cheesecakes, with no immediate external stimulation.

We noted above that a goal representation naturally includes elements of the context that have been co-active with it, either when it was formed or subsequently. Activation of these contextual representations could thus spread to the goal representation itself. The sight of the coffee shop where you had a good cheesecake might activate the goal of eating cheesecake, because representations of the shop are included in the representation of the goal.

When a given goal representation is active, it constitutes an element of internal context for all other processing. In the most straightforward case, this means that it will lead to activation of representations related to achievement of the goal, which is to say that it is doing what goals do. This again is a matter of spreading activation based on shared features, i.e. component representations. The spreading activation might also include representations of reasons for not pursuing the goal ('think of the calories', or 'money is tight these days'). Any or all of these representations, while active, will then constitute internal context for ongoing processing.

The other aspect of the influence of goals on processing involves the effect of unrelated but active representations in CS. Whenever another representation is active while the goal representation is active, the processor must reconcile the two. This could mean treating the new representation as part of achieving the goal, possibly adjusting it for that purpose. It could mean inhibiting the new representation. But if the new representation is the more active of the two, it could mean setting aside the goal. This is distraction.

Goal representations thus do what controllers are supposed to do. Their importance in this role can be seen in the many sources that treat them as definitional for executive function. Of the 30 definitions quoted by Goldstein, Naglieri, Princiotta, and Otero (2014), fully half include the word 'goal'. When goals are not explicitly mentioned in a definition, their importance is likely being treated as a background assumption. The importance of goals in control also shows in Carver and Scheier's (1998) extensive analysis.

2.2 Goals as language controllers

The importance of goals for control in general certainly extends to their role in language processing. To take the simplest of examples, the goal of obtaining a slice of cheesecake can result in activation/construction of a representation of a subgoal of verbally ordering one or of asking your companion to get one for you. Either is likely to lead to construction of a CS representation constituting the message to be expressed, which then directly influences language production. More interesting, perhaps, and certainly more relevant to a discussion of language control, is the question of how goals help to determine which of the bilingual's languages is used in a given case, and this will be the emphasis here.

A great many goals are potentially involved in (bilingual) language processing. They include the general, straightforward goal(s) motivating the utterance, like getting the cheesecake in the above example. Communication is usually, though not necessarily, a goal. Linguistic utterances can be shaped by a variety of general social goals such as affiliation, power, and face. A speaker can be trying to give the interlocutor particular impressions about his/her attitude, such as friendliness, hostility, interest, gratitude, and so on. The guidance provided by goals can be a very dynamic process, with active goals frequently shifting on the basis of responses, verbal or nonverbal, from another person or changes in the situation or additional thoughts or feelings that come to mind.

When one of these goals, or any of countless others, is active its activity spreads in CS via shared features (component representations). Any representation that contains or is contained in the goal representation will receive stimulation to varying degrees, along with any others that overlap with it. Faced with this activity, the CS processor carries out its function of making a unified representation from the active representations. This new representation will include the active goals (to the extent that they are compatible with one another) and additional representations that can be combined with them.

The process of constructing this conceptual representation based on active goals inevitably interacts with outside-in context, simply because this context consists of active conceptual representations, activated by current or recent input. Context is likely to include for instance representations of the interlocutor. If an active representation of that person in CS includes the information that he/she speaks English but not Polish, and the goal is to communicate with this particular person, the concept of speaking in Polish will not be compatible with the active goal, while the concept of speaking in English will. In other words the CS processor might be able to make a coherent composite representation that includes English-speaking but not one that includes Polish-speaking.

Active representations in CS automatically stimulate coindexed representations in syntactic structures (SS), which then stimulate activity in phonological structures (PS). In this way linguistic processing is shaped by goals, interacting with outside-in context in CS. It should be kept in mind, though, that goals and outside-in context *influence* production but do not *control* it, as the nature and current state of the linguistic modules themselves are also crucial factors. Each linguistic processor must construct a representation consistent with its own inbuilt principles, and this activity is strongly influenced by the current state of the linguistic modules, notably including the variable resting activation levels of individual syntactic and phonological representations, making them more or less available for processing, independent of the influences coming from CS.

Finally, we should note that language control is even more complex and heterarchical than this discussion suggests. A complete picture has to include the undeniably important roles played by the other elements of inherently internal context, to which we now turn.

3. Value as controller

We suggested above that value is the most basic life regulator and a pervasive feature of internal context. Not surprisingly, then, it is also a major factor underlying control, in general and specifically in language processing.

3.1 Value as cognitive controller

The importance of value as cognitive controller is based in part on the very widespread connections of value representations throughout the system, most notably to representations in the conceptual system. Because of their high activation levels, the influence exerted by these value representations can be very strong, its degree depending on the resting activation levels of the indexes connecting them to the various CS representations. A strong connection can in effect act as a booster for the CS representation, increasing its current activation level and maintaining it at the higher level. The effect of this boost is to make the representation more available to the conceptual processor and, for the case of language processing, encourage activation of any SS representations with which it is coindexed – an important factor in language selection, we will suggest below.

The most basic control function of value is seen in the classic approach-avoidance dichotomy, positive value underlying approach and negative value underlying avoidance. It also plays a prominent role in neuroscience. Damasio (2010) seems to treat value as a substitute for the control function of attention. For Edelman (1992, 2004, 2006a, 2006b), value is a central and pervasive factor in neural processing quite generally, notably in consciousness. More generally, considerable evidence exists that the amygdala's function is to evaluate – i.e. assign value to – stimuli in terms of their significance for the organism (Morrison & Salzman, 2010; Sander, Grafman, & Zalla, 2003; Sergerie, Chochol, & Armony, 2008).

The importance of value as controller is nicely shown by the role it plays in decision making (see Barrett, 2005; Charland, 2005; Dolan, 2002; Evans, 2004; Gray, Schaefer, Braver, & Most, 2005; Mameli, 2004; Thagard, 2006). According to a prominent view, the value associated with each option is a crucial (or *the* crucial) factor in the decision, where in our terms the option is a CS representation and its value is the connection to value representations in AfS. In the *somatic marker* theory of Damasio (1994, 2003; Damasio, Tranel, & Damasio, 1998), the most prominent work in this area, a somatic marker constitutes the emotional value of an option, positive or negative, associated with it on the basis of past experience, and the outcome of the decision making is determined in part (or entirely – Mameli, 2004) by this valuation. The importance of value can also be seen in economic accounts of decision making, prominently involving neural work (see Ariely, 2009; Glimcher, Camerer, Fehr, Poldrack, 2009; Kahneman, 2011).

Decision making is an instance of processing in which the processor is faced with more than one option, in the form of active representations in CS, and must end up with a single active representation, constituting the outcome of the decision. Value is an essential element of the internal context influencing this processing. It has a similar, if less direct effect on linguistic processing, to which we now turn. Note, in passing, that the term 'decision-making' is an invitation to homuncular explanations. Here again we see the need for the kind of non-homuncular approach offered by the MCF.

3.2 Value as language controller

Value is about positive vs. negative assessments. It is a crucial element of internal context very generally, and therefore of cognitive control. Its influence naturally extends to activity in the linguistic modules, but it is necessarily indirect in this case, as affective representations do not directly connect to SS or PS. Their influence on linguistic processing is instead through their connections to CS, in two ways. First CS is home to linguistic meanings, which is to say that conceptual representations constitute one end of the CS-SS-PS chains that are the linguistic items. Thus value can influence linguistic processing in a relatively direct way by its effects on the CS component of the chain. More indirect influences on the CS component – and therefore on linguistic processing – are also a normal part of processing. The conceptual system is home to goal and self representations, which are themselves connected to affective representations. Value can thus indirectly influence linguistic processing by directly influencing the activity of these representations. This is why affective factors cannot simply be ignored or set aside for later in explanations of linguistic behavior.

Value exerts its control function by raising activation levels of representations in CS with which it is coindexed. The extent of the boost depends on the index, specifically its resting activation level. To say that a person cares very much about prestige is to say that the CS representation of prestige is coindexed with positive value in AfS and that the index has a very high resting level. Value is also an essential component of every goal, as a goal is by definition a combination of *SEEK* with a positively valued state representation. The activation level of the index which makes the state positive or negative contributes substantially to the level of the state representation, and therefore to the overall level of the goal representation. The strength of a goal as controller is thus greatly affected by its value connections. If the desired state is highly valued – the index connecting it to positive value has a high activation level – this will have an amplifying effect, making the goal more important. A strong connection to negative value will similarly raise the goal's activation level, making avoidance of the negative state more important.

In the realm of bilingual processing, value assessments can apply to a language as a whole or to aspects of the language, to a language within a context or to aspects of it within a context, to the person's ability in the language or to aspects of it. A language can be valued, positively or negatively, because of its association with prestige or group identity (identity based on ethnicity, family, peers, etc.) or for its pragmatic usefulness. The value assignment can be to broader representations that include both the language and specific contextual representations.

Heritage language speakers provide good examples of the role of value in bilingual processing. Researchers distinguish between the language of the wider community and the 'home' language where the mother tongue of the parents (or at least one parent) is spoken usually in an effort to maintain the language spoken in the country from which they emigrated but also for practical reasons because it remains for the adults the easiest and most natural means of communication with their children. While the home location may normally favor the use of the home language, children may have developed negative associations with that language as a result of interacting with the speakers of the outside language where the heritage (or indigenous minority) language is treated as having a low status in the

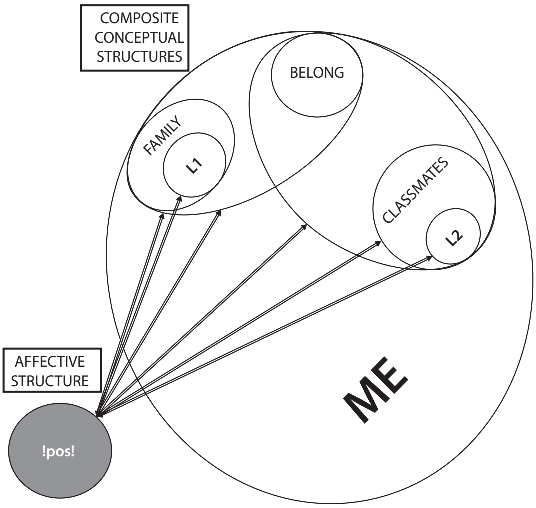

Figure 7.1 The typical status of the two languages in the meta-self of a heritage speaker

community at large, or simply as a result of forming close bonds with peers from that community.

Let us look then more specifically at the case of a young heritage speaker dealing with one language at home and another in public, particularly with classmates. In the latter context the L2 is likely to be highly valued while the heritage language is valued, more variably, at home. The situation is depicted in Figure 7.1.

The value of the L2 is associated, in part, with the person's sense of belonging to the classmate group. In other words the representation of this belongingness is coindexed with positive value. The person also has a sense of belonging to family and values this belongingness, as shown in the figure by the association of positive value with the representation.

The figure shows the case in which the languages are valued more or less equally, each in its own domain, and so each is freely used, in its own domain. But some children develop an unwillingness to use their heritage language even at home, a situation that is depicted in Figure 7.2.

This variable development of an unwillingness to use the heritage language can be readily explained in terms of contextual representations and their association with linguistic representations. Different people at different times in different situations can be more or less 'aware' of their current context. This is to say that outside-in contextual representations are active to varying degrees. Experiencing negative affect toward use of the heritage language in a situation outside the home thus might lead to negative valuation of the language specifically in that context or more generally, i.e. with little or no incorporation of the outside-the-home context. In the former case the person will be reluctant to speak the heritage language

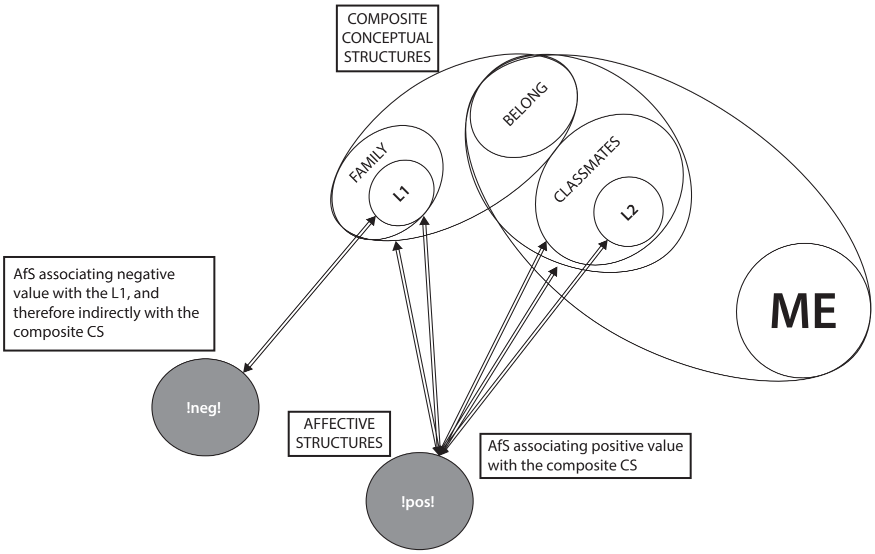

Figure 7.2 A heritage speaker who rejects the heritage language

in public, particularly with peers, but will have no qualms about using it at home, while in the latter case he/she will be reluctant to use it even at home.

This interaction between language valuation and context is a fairly general phenomenon. As another example, in Taiwan the Taiwanese language might have strong positive value within the context of a group of friends drinking beer together but not at a more formal gathering, where Mandarin is likely to be valued. This is to say that representations of features such as FORMAL vs. INFORMAL acquire their value primarily within larger representations. Those that include INFORMAL, such as representations of Taiwanese, are positively valued in representations of informal situations and negatively valued in representations of formal situations. Taiwanese – meaning either the language representation or individual PS/SS/CS chains belonging to the language – may well be valued in itself, positively or negatively, but its value is also context-dependent in the sense that its combination with different contextual representations can yield very different value assignments.[1]

Value assignments can also apply to aspects of a language or aspects of one's ability in that language. A shy person might have a negative view of speaking the L2 but a positive evaluation of reading and maybe listening in it. Similarly, a person could be unhappy about his/her accent in the L2 and therefore have a negative

1. This discussion is a simplification, intended as an illustration rather than a definitive account. A more thorough account would require extensive social and psychological analysis, which is well beyond the scope of this work.

valuation of speaking, without necessarily being negative about the language in general or about other aspects of its use. And again these values can differ as a function of context. A formal public speaking context could give L2 speech an especially strong negative value while a casual, supportive context would have the opposite effect. This is to say, again, that the value indexes can be attached to representations that include both the language, or an aspect of its use, and a particular context.

To take a more positive example, good feelings toward a person can influence the language that is used in speaking to that person. When two Mandarin-Taiwanese bilinguals are together, for example, they might well feel that the use of Taiwanese establishes a sense of closeness that might be lacking if they spoke in Mandarin. In such a case positive value is associated with a CS representation of closeness with the other person, leading to construction of a goal of seeking closeness with that person. Established associations between closeness and the Taiwanese language then result in activation of the TAIWANESE representation in CS and various CS representations that form part of Taiwanese CS-SS-PS chains. The end result is a strong influence in favor of speech in Taiwanese rather than Mandarin.

4. Emotion as controller

Emotion is crucial as a source of activation throughout the system. The things that receive extensive processing are the things that matter to us, and the things that matter to us are the things that evoke emotion; if something has no significance for us, it is not likely to produce any emotional reaction or to be the object of extensive processing. The importance of emotion in (bilingual) language use is clear and has been the topic of considerable discussion (e.g. Altarriba, 2013; Altarriba & Basnight-Brown, 2011; Dewaele, 2010; Dulay & Burt, 1977; Ivaz, Costa, & Duñabeitia, 2016; Kim & Starks, 2008; Krashen, 1985; Pavlenko, 2005b; Schumann, 1997; Sharwood Smith, 2014a; Sharwood Smith, 2017c). So emotion is a major type of control, in general and specifically for language processing.

4.1 Emotion as cognitive controller

Emotions are commonly left out of accounts of cognitive control, probably reflecting traditional separations between cognition and emotion. The viability of this separation has become increasingly doubtful (see Barrett, Niedenthal, & Winkielman, 2005; Evans & Cruse, 2004; Izard, 2009; Lane & Nadel, 2000; Moore & Oaksford, 2002; Phelps, 2006; Storbeck & Clore, 2007), so it is important to consider the place of emotion in an account of control. Emotions can also be targets of activation and inhibition just like other representations.[2]

The topic of emotion as controller is an extension of value as controller, since value is a basic component of all emotion representations. Moving from value to emotion means adding elements to the positive/negative assessment. Fear is about avoiding a bad development. Anger, on the other hand, seeks to aggressively change a bad situation. Positive value within a given emotion can lead to an absence of activity (contentment, satisfaction) or can encourage action to achieve an anticipated state (hope, expectation). All of these depend of course on connections between affective representations and representations in other modules.

AfS representations are connected, first, to perceptual modules. This is largely the attentional function of emotion and value – we pay attention to things that matter to us. Also important are connections to motor systems, connections that show most clearly in cases in which we react to a situation without rational thought, based on emotion, or possibly desire, itch, fatigue, or any of the other low-level mechanisms that constitute AfS representations. For more interesting sorts of actions, though, we do not normally see emotion acting in isolation from what are traditionally called cognitive processes, i.e. CS activity, because value and emotion necessarily interact with goals. Goals are not meaningful unless they, and the objects and actions they involve, are valued – if nothing is better or worse to us than anything else, there cannot be goals. Thus the goals, objects, and actions necessarily have value (with accompanying emotion) attached to them. This applies to all types of goals, from avoiding pain to achieving fame to reaching for a glass of water. Specific emotions can also be associated with goals; a particular goal might be based on and driven by anger or love, for instance. The existence and importance of AfS connections to the meta-self is also clear, as we care (a great deal) about self-image and anything that supports it or challenges it.

In a sense the importance of value and emotion as controllers is obvious: We know that our feelings of the moment greatly influence our thinking and behavior. No less important, though, are implicit affective memories stored in the form of AfS representations and in their connections with CS representations. Activating CS representations, possibly in novel combinations, inevitably means activating their connections to AfS and thereby bringing into play, often with little or no awareness, our previous appraisals involving those representations. In the words of Johnston and Olson (2015, p. 307), "emotional reactions provide a critical summary of our past experience with a situation or event, and this summary

2. This is the subject of emotion regulation (see Cohen, Henik, & Moyal, 2012; Cole, Martin, & Dennis, 2004; Gross, 1999; Johnston & Olson, 2015; Morillas-Romero, Tortella-Feliu, Balle, & Bornas, 2014; Ochsner, Silvers, & Buhle, 2012; Silvers, Buhle, & Ochsner, 2013).

is experienced as a 'gut' feeling that provides important time and effort-saving analyses of situations that are often too complex for rational dissection". This role was noted above in the discussion of decision making, particularly in regard to Damasio's somatic marker hypothesis. Influences from AfS are a normal and essential part of thinking and behavior, as can be seen in the inability of patients to make ordinary daily-life choices when they have suffered damage to ventromedial prefrontal cortex[3] (e.g. Damasio, 1994).

4.2 Emotion as language controller

We noted above that the control effects of emotion are essentially an extension and refinement of those of its primary component: value. Applying these ideas to bilingual processing now, the value associated with a language or an aspect of the language or use of the language can involve specific emotions, beyond the simple +/– of value. Negative value associated with speaking in the L2 could in principle be part of fear, anger, disgust, or sadness, with very different influences on processing. The different emotions can thus be associated with very different kinds of goals. These differences can play a role in determining which of the bilingual's languages is used on any given occasion and can have substantial influence on bilingual processing in general, including code-switching, which we will consider in the following chapter.

As described in Chapter 2, we do not hypothesize direct connections between affective representations and the linguistic modules, but indirect connections are quite important. One type of indirect connection is via perceptual modules. By influencing what we focus on and how we perceive it, affect helps to select the linguistic input that is to be processed. When the selection is of non-linguistic or paralinguistic features of the environment, this process helps to shape outside-in context, in the form of CS representations of the environment. The other indirect influence of AfS on linguistic processing involves connections to CS, including the CS selves. Particular emotions are commonly associated with representations of outside-in context in CS, with varying consequences. When negative value is associated with a person, for example, the specific negative emotion can have a strong impact on linguistic behavior. Fear can produce a reluctance to speak in the weaker language (or possibly in a language spoken by that person). Anger, on the other hand, can encourage speech to that person, speech of particular types.

In our terms, the !fear! representation in AfS is coindexed with CS representations of the feared person, possibly also with larger representations including both it and contexts in which interaction with the person is possible. Activation of such

3. The relevant region has also been characterized as part of orbito-frontal cortex.

representations leads to activation of the goal of avoiding contact with that person, or the construction of such a goal representation if it does not already exist. This active goal representation then influences linguistic behavior accordingly, encouraging efforts to avoid or minimize interaction or to avoid using a weak language or a language the person understands. Avoidance of speech in such a case could make use of a veto representation as discussed in Chapter 6.

If !anger! is coindexed with CS representations of the person, then activation of those representations, possibly in context, can activate or trigger construction of confrontational goals. These active goals might then lead to aggressive speech directed at that person, subject to other contextual influences and goals, probably in a common language but possibly in a language the person does not understand well, again subject to other contextual influences. And of course it is possible, and perhaps normal, to feel more than one emotion toward a person, fear and anger together in this case, leading to a competition between goal representations for dominance of CS and therefore influence on linguistic processing.

The same sort of account applies to problems of anxiety associated with the use of an L2. The anxiety reflects coindexation of representations of the language with an AfS representation of the emotion. When those linguistic representations are active, activity of anxiety thus follows. Minimizing anxiety is a natural and presumably innate goal, which is activated whenever anxiety is present. Its presence will thus lead to activation or establishment of goals of avoiding use of the language.

5. Putting it together: Goals, value, and emotion as language controllers

To summarize the chapter to this point, goals, value, and emotion all act as language controllers, operating on the CS stage that is set by outside-in context. A high-level view of their role in language production is shown in Figure 7.3.

The endpoint[4] of the control processes is construction of a CS representation that constitutes the message that is to be expressed. This representation is shaped by all the factors of internal context. Outside-in context begins with activity of perceptual representations, which leads to activation and/or construction of associated conceptual representations, which then constitute the immediate outside-in context for language production. These representations interact with active goals in CS and active value and emotion representations in AfS to shape the message representation, which includes the core meaning of the utterance to be produced

4. Here we are abstracting away from the back and forth that goes on between SS and CS, and indeed between any pair of modules, during processing.

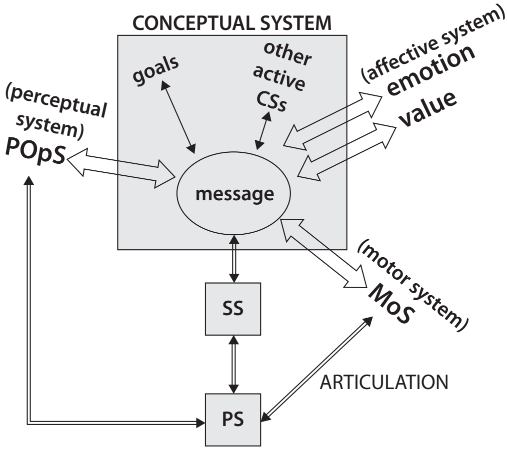

Figure 7.3 Contextual influences on construction of a message representation

and also other active elements in CS, including outside-in context and active goals. Activity of this message representation then results in activation of all the SS representations coindexed with its components, beginning the strictly linguistic processing that will ultimately result in an utterance.

The figure presents a somewhat abstract, high-level view of the control process. A given CS-SS connection could involve items belonging to one of the bilingual's languages or the other, or to both. In some cases a CS language representation, e.g. MANDARIN, will be included, with its connections to SS representations. Note also that to this point we have simplified the presentation by excluding self, which is the topic of the following chapter.

6. Bilingual advantage and executive control

There has been much in the recent literature about the advantages of knowing and regularly using more than one language both in childhood and old age – the 'bilingual advantage'. In this section we will briefly review ideas and research in this area and consider how they might be understood and further studied within the account of control proposed here.

6.1 The state of the field

Recent research into the bilingual advantage has been reported extensively in the press, particularly in countries where bilingualism is mistakenly seen by many as something exceptional rather than normal and therefore especially deserving of admiration. Press coverage has inevitably led to simplifications and exaggerations that do not necessarily reflect the more careful examination of the issue in the research literature; it seems also to have provoked heated negative reactions amongst some researchers as well (Kroll, Dussias, Bice, & Perrotti, 2015; Paap & Greenberg, 2013; Paap, Johnson, & Sawi, 2015; Valian, 2015).

The essential claim is that entertaining more than one language in the head as well as switching between languages creates a resource, called a 'reserve'. Since all linguistic resources are mobilized and compete in any linguistic activity, bilinguals as well as those regularly using distinct dialects of the same language have to keep the right balance between their language systems in such a way as to serve their current purposes (Antoniou, Grohmann, Kambanaros, & Katsos, 2016; see also Castro, Rothman, & Westergaard, 2017; Kirk, Kempe, Scott-Brown, Philipp, & Declerck, 2018). This means either consistently using one language rather than another or, on appropriate occasions, switching from one to another. The extra processing required to keep whatever happens to be the currently used language more highly activated than the other(s), it is claimed, has a beneficial long-term effect. It creates increased mental flexibility which is also accompanied by observable changes in neural structure (Bialystok, Craik, & Luk, 2012; Bialystok, Poarch, Luo, & Craik, 2014; Marton, Goral, Campanelli, Yoon, & Obler, 2017). This includes an increased connectivity in the brain as fMRI studies have shown (Pliatsikas & Luk, 2016). In other words, the benefits come in the form of two kinds of reserve: *cognitive* reserve that is supposed to provide the mental flexibility and *brain* (or *neural*) reserve that is responsible for the corresponding synaptic growth and increased connectivity in the brain (Katzmann, 1993; Perani & Abutalebi, 2015; Perani et al., 2017; Stern, 2009). This distinction between the two kinds of reserve is in line with our concern, while facilitating associations between neurological and psychological research, to keep these two levels of description quite distinct.

There is indeed some impressive evidence which has withstood skepticism concerning the beneficial effects of bilingualism on executive function and, more specifically, for older bilinguals faced with the onset of dementia.[5] It has been claimed justifiably that bilinguals with Alzheimer's have a 4–6 year advantage over their monolingual peers as far as the behavioral symptoms are concerned (Alladi et al., 2013; Craik, Bialystok, & Freedman, 2010; Woumans et al., 2014; Zahodne, Schofield, Farrell, & Manly, 2014). That means that bilinguals with significant deterioration in their brains will be able to function for a time as though their

5. Some disadvantages of bilingualism should also be acknowledged, such as delays in vocabulary growth in a particular language (Pearson, Fernandez, & Oller, 1993) and possibly interference between languages. These are, we suggest, a very small price to pay for all the linguistic and cultural benefits of knowing more than one language.

brains were healthy, the brains having developed ways round the deficits that should normally affect their behavior. The weight of evidence definitely seems to favor the notion that bilingualism, apart from being normal, is very beneficial in many different respects especially where more than one language is used regularly.

6.2 The bilingual advantage in the MCF

What has the framework to say about the bilingual advantage? The need for comprehensive theoretical models to address such questions has been voiced by Marton (2015) to account for what she calls the 'bilingual experience'. The current framework should certainly provide a basis for framing theories that distinguish the psychological mechanisms involved (see discussion in Sharwood Smith, 2014b). 'Executive control' and 'executive function' are concepts that keep cropping up in these discussions, and of course are concepts that the MCF has much to say about. What it has to say differs from some characterizations of executive control in the literature, most importantly in that it does not involve any overarching, domain-general controller. It favors instead an account of executive control as an interaction between heterarchically organized systems, i.e. with no central supervisory module. The framework architecture will thus be compatible with those neurolinguistic accounts of executive control that implicate a range of different locations and pathways rather than confining control to one single system (Abutalebi & Green, 2008).

The heart of an MCF account has to be the conceptual system, which functions as a hub for networks of representations that extend across a number of different modules and, as such, serves as the crossroads for linguistic processing and its internal context. The focus should be especially on the conceptual processor, as it constructs the representations in CS that constitute the immediate context of linguistic processing, as well as the meaning of utterances. More generally, it is the heart of abstract thinking. For this reason, dementia and cognitive decline in general should be explained, in large part, by its deterioration.

If the conceptual processor can decay with age or lack of use, as seems natural, then mental exercise should limit or delay this decay. In MCF terms, this exercise should mean construction of new representations from those that have been activated by the various factors of internal context. A great deal of processing and behavior can be carried out simply with the use of existing representations, activated by the context; in other words much of what we do in ordinary life is quite routine. Such activity should not constitute exercise for the processor, which plays little or no role in it.

Applying these ideas to bilingual processing, a possible hypothesis is that the task of juggling two languages, as an example of mental exercise, can have beneficial effects on the function of the conceptual processor, suggesting at least a partial account of the bilingual advantage. The extent of the benefit should depend on the extent to which the bilingual experience involves creation of new representations rather than simply activation of existing ones. Consider two extreme types of bilingualism, representing the ends of a continuum. In one case every instance of language use involves well-established contextual representations, each with well-established connections to just one of the languages. In this case the use of one language rather than the other follows directly from the various factors of internal context and the connections they have, directly or indirectly, with SS representations. As a result, the conceptual processor has little or no involvement and no cognitive advantage should result from the person's use of two languages.

At the other extreme, the person is constantly using the languages in novel ways. This could mean there is great variety of contexts in his/her life and that choice of the language to be used is a matter of constructing a CS representation of the novel circumstances in relation to language use. A likely example is frequently talking to people of differing language groups who are new to his/her experience and are therefore not yet represented in CS. This experience could also involve variable goals requiring the use of one or the other language in daily life. Or it could mean talking about a range of novel topics. These factors should also be relevant to monolinguals, but matching language to novel internal context (i.e. constructing a representation of that match) adds an important dimension to the processor's task.

Since the MCF is about psychological functioning it is cautious about claims as regards the neural underpinnings of the bilingual advantage. Still, as a framework that is supposed to be neuroscientifically plausible, it should at least be possible to relate particular psychological mechanisms that have been implicated in claims about cognitive reserve to observed changes in the brain that have been associated with neural reserve. The effect should be centered in PFC which, as suggested in Chapter 6, is associated with the conceptual processor. This is only the beginning of an answer, though, as PFC contains a great many parts and current understanding of them remains limited. Inferior parietal cortex, also associated with control, is another likely candidate. The changes underlying the bilingual advantage can also be expected to have effects on the function of all the systems underlying internal context, given their constant interaction with CS processing. We will not try to go into details here.

Some of the ideas presented here are of course speculative, and so this discussion must be considered very tentative, more as suggestions for future research than as concrete proposals. This, again, is a primary function of a framework like the MCF. An important issue for any such future work is the homunculus problem: The conceptual processor must not become an unanalyzed intelligence.

It should instead be treated as a system of explicit mechanisms and principles, and its behavior should be fully explicable, at least in principle, in terms of the components of the system and the ways they interact.

7. Relations to existing treatments of language control

Language control is of course a prominent topic in bilingualism, and a number of theoretical treatments of it can be found in the literature, though most work on the subject does not seem to be tied to any clear notions of what control is, relying instead on operational definitions – control is what is measured in the various experimental paradigms. Our approach contrasts with existing approaches in some important respects, but at a more fundamental level might be seen not as a rival to them but rather as a way to better understand and develop them. In this section we will first consider the major contrasts and then look, very selectively, at a few prominent approaches to language control and consider how they might be understood in terms of our framework.

7.1 Fundamental contrasts

At the most fundamental level our approach contrasts with existing accounts in three interrelated respects. First, MCF is a general framework rather than a specific theory (see Truscott & Sharwood Smith, in press). A theory offers specific, testable claims. Its success is judged as much by its ability to make clear, empirically testable predictions as by its ability to explain phenomena. A framework, on the other hand, is not in the business of making specific predictions. Predictions might well emerge from it, but the goal is to provide a coherent set of research-based assumptions that can guide research, inspire formulation of specific theories, and interpret findings in terms of general ideas in the field and possibly in related fields. Its scope can vary from narrow, 'local' topics within the field to broad, interdisciplinary coverage. MCF is an example of a relatively broad framework.

In most cases existing theories are relatively narrow, not seeking to explain language control in general but rather focusing on a particular aspect of the topic. This is not a criticism of the theories; work at this level is essential. The point is that 'local' theory and research is not sufficient; if we are to have a genuine understanding of language control, or any other topic, such work must fit into the sort of broad framework which alone can provide such understanding. A key issue is thus the possibility of incorporating the local theories in the MCF framework, translating their principles and findings into our terms. These revised perspectives on the theories might then suggest further research to test and develop those theories.

The second, closely related contrast is that we make use of an explicit account of the cognitive system, placing control phenomena in this context and seeking to understand them in terms of what is known about the system as a whole, or at least of a reasonable view of the system based on existing research. This is not to say that existing theories ignore work in related disciplines. But the common result of the relatively narrow focus is that connections are not broad or systematic and they tend to involve implicit assumptions, which can be spelled out in an appropriate framework.

The third fundamental respect in which our approach contrasts with existing approaches is that the latter tend to treat control as a thing in itself, while the MCF account sees it as derivative, seeking to understand the factors underlying control and explaining the phenomena in terms of those factors. A consequence of the assumption that control is a genuine entity is that explanation does not achieve the depth that it might if more basic factors were taken into account. It also raises an issue that we have discussed at several points. The appeal to an unanalyzed 'control' looks a great deal like the kind of homuncular explanation that must ultimately be avoided in theoretical development. This is not to dismiss efforts to achieve explanation at the general level of 'control'. Such efforts could conceivably offer insights that are obscured at the level of individual controllers. But this point does not alter the fact that understanding of the phenomena at the more fundamental level is essential.

7.2 Inhibitory control and the adaptive control hypothesis

The neurolinguist David Green proposed his inhibitory control (IC) model in order to stimulate discussion of the ways in which bilinguals control their two language systems (Green, 1986, 1998). His approach was to outline a functional model of behavior to guide investigation at both phonological and neurolinguistic levels. He later teamed up with Jubin Abutalebi to develop a neurocognitive language control model, which they discussed within the framework of the *adaptive control hypothesis* (Green & Abutalebi, 2013; see also Abutalebi & Green, 2007, 2008). In a more recent publication they used their model to make proposals about a neural reserve that develops in the brain as a result of adaptive processes which are in turn associated with the cognitive advantages that bilinguals have been claimed to possess (Green & Abutalebi, 2016). The topics discussed by these authors are ones that have been important also in this book. Since in many cases there appear to be parallels and at least some measure of compatibility between the MCF and the ideas, specific concepts and detailed investigations that have been discussed by Green and Abutalebi, they are worth a separate mention at this point.

Green's IC model follows on from an earlier translation and picture naming experiment reported by Kroll and Stewart (1994) applying their Revised Hierarchical Model. According to Green's model, which, unlike the MCF, assumes the existence of language tags (language nodes) on lemmas (roughly equivalent to CS in the MCF), the way in which a bilingual controls which language is to be used is the outcome of multiple levels of control: A language task schema modulated by a higher level of control reactively inhibits potential competitors by virtue of language tags. In other words, there is no simple switch mechanism. Language task schemas, once they are established, can be triggered bottom-up but they have to be monitored to ensure performance proceeds as appropriate. As in the MCF and other approaches mentioned elsewhere, it is assumed that both (or all) languages are always activated in parallel so the question is how, for example, L1 word forms get inhibited while L2 ones do not. In production, in the IC model, a supervisory attentional system (SAS) expresses the intention to perform a specific language task: This affects the activation of language task schemas that compete to control output. These schemas exert control by activating and inhibiting given tags at the lemma level.

Given the basis and motivation behind the IC model in the context of contemporary work on bilingual processing, the model clearly focuses on a small part of what is included in the MCF account. We also have different ways of explaining what is expressed in the IC model by language tags, supervisory systems and inhibition although we are neutral on when inhibitory mechanisms function purely at the neural level or whether close equivalents exist in cognitive architecture as well. Subsequent development of what began as the IC model is more complex.

In their adaptive control hypothesis, which is an update of their 2007 paper, Green and Abutalebi (2013) distinguish eight control processes: *goal maintenance*, *conflict monitoring*, *interference suppression*, *salient cue detection*, *selective response inhibition*, *task disengagement*, *task engagement* and *opportunistic planning*. Control processes may each undergo adaptations of their neural capacity or efficiency or in how they work, together in tandem or in cascade with other control processes. These processes themselves adapt to the demands imposed on them by three different contexts discussed in this article namely *single language*, *dual language* and *dense code-switching contexts*, the last-mentioned context being where bilinguals routinely use both languages in particular ways within a single utterance. In all of them it is assumed that both languages are active. Each of the three interactional contexts imposes different demands on the different control processes. In the first two, single and dual language contexts, the language task schemas compete with one another whereas in the third, the dense code-switching context, they are in a collaborative relationship. In answering the question 'what drives the system to adapt its control processes?', they identify 'interactional cost' as a factor. Adaptation means that the parameters of control processes are changed, including how they coordinate with other control processes.

A translation of these proposals into MCF terms would involve explaining the eight control processes in terms of general processing and particularly how they work with respect to control as we discuss it in this chapter and in Chapters 6 and 8. We will not attempt this large task here. One specific question that deserves at least some speculative discussion is how the adaptive control hypothesis relates to the issue of hierarchical vs. heterarchical control. The hypothesis can be seen as a step toward heterarchy in that the control processes are not fixed but rather change in response to the speaker's circumstances,[6] which for us are a matter of outside-in context, particularly representations of the situation in conceptual structures. Changes in the control processes could occur because the altered outside-in context triggers new interactions among a variety of elements (for us, these are goals, value, emotion, and self), and these interactions in themselves determine exactly what changes will occur. This would be a heterarchical system, of the sort we favor.

Abutalebi and Green (2016) reviewed some of the findings that have followed from their earlier work developing the language control system, detailing neural regions involved in language control and which had been reported in various studies, and they looked further at how the control network is adapted with special reference to neural reserve. A number of specific neural regions are identified as being of special relevance to cognitive control. These include the ACC (anterior cingulate cortex), usually related to conflict and error monitoring and firmly established as being involved in cognitive control. The dorsal ACC is associated with conflict monitoring. The pre-supplementary motor area is involved in initiating speech in language switching but has also been associated with conflict resolution in non-linguistic tasks. Gray matter density in these areas is a relevant feature with increased density in the dorsal ACC being associated with more efficient bilingual performance, also present in elderly bilinguals. The authors also note that a decline in white matter is associated with the aging brain and that the study of Luk, Bialystok, Craik, & Grady (2011) indicates that bilingualism may delay this process.

As mentioned elsewhere the prefrontal cortex (PFC) is identified as the major area for cognitive control. The left PFC is involved in response control such as response selection and suppression and its counterpart of the right in domain-general response inhibition. Moving now away from the PFC to the inferior parietal lobes, the authors propose that during language switching, the left inferior parietal lobule is involved in biasing language selection away from the language not in use, while its right counterpart is responsible for biasing selection towards

6. Thanks are due to David Green for confirming the heterarchical nature of this and his earlier inhibitory control hypothesis.

the language in use (Abutalebi & Green, 2008). Also involved in language control in bilinguals are a number of subcortical structures, notably the left head of the caudate nucleus and the left putamen. Finally the cerebellum is a critical structure since it is linked to all the regions of the brain which are presumed to be part of the language network.

7.3 The Bilingual Interactive Activation Plus (BIA+) model

Adaptive Control Theory focuses on production, and this is the area where we can most meaningfully speak of control. In comprehension, processing is driven primarily by input, leaving much less room for control as it is commonly understood. This can be seen in one of the major theories of bilingual representation that we summarized in Chapter 5, the BIA+ model (Dijkstra & van Heuven, 2002; see also Dijkstra, van Jaarsveld, & Ten Brinke, 1998; Thomas & van Heuven, 2005; van Heuven & Dijkstra, 2010). It is based on the earlier BIA model (Dijkstra & van Heuven, 1998), which in turn was based on the Interactive Activation theory of McClelland and Rumelhart (1981) and Rumelhart and McClelland (1982), dealing with monolingual comprehension. The concern is with bilingual visual word recognition (with possible extension to auditory word recognition).

BIA+ includes a 'task/decision system', which is about control – but not language control. Its function is to account for the way that participants in standard experimental paradigms deal with the demands of the tasks they are given, such as deciding whether an input string is or is not a word. It is a nonlinguistic task separate from the actual word identification process, and the authors stress that it cannot control activation of languages or of specific items. In MCF this system is about goals, established by the experimental task. This type of goal is likely to have an indirect effect on language use, activating other goals that are more directly involved.

Apart from this added system, they did not show much concern with ideas of control, stating that participants cannot control activation of languages or language items in the experimental tasks. This is presumably control in the deliberate sense. But we can still speak of how, in this and related theories, a particular language or items of a particular language come to be used – control in the broader sense. In BIA+ input words activate candidates from both languages (non-selectively), but the words are tagged with the language they belong to and active words activate their language node, cumulatively. An active language node then inhibits all words in the other language.

Dijkstra and van Heuven (2002) concluded that activation of the language nodes is not influenced by any non-linguistic factors, coming entirely from current linguistic input and previous linguistic context, and that the language nodes have only a small influence on word activation anyway, which in effect means that recognition of the language being processed does not play a significant role in comprehension. It should be kept in mind, though, that this model was made to account for the findings of laboratory experiments, relying on artificial tasks that typically involve isolated words. Some caution is called for in applying it to real-life language use. Interesting questions also exist about value and emotion as possible controllers in comprehension.

7.4 Bilingual Language Interaction Network for Comprehension of Speech (BLINCS)

Shook and Marian (2013) developed an approach based on extensive interaction among its elements. It is described as a combined connectionist and distributed model of bilingual spoken language comprehension. As the name suggests, BLINCS was intended for comprehension and specifically for comprehension of speech, but the principles should be applicable much more generally. Most importantly for our purposes, it offers a general principle for language control.

The central idea is essentially the point we considered above (Chapter 6, Section 4.2.1), that the language to be used can be determined to some extent, possibly a very great extent, by the form that the language representations take during acquisition. Items that belong to the same language tend to appear together in the input and therefore to become associated with one another in the language system. Activation of one or more of these items thus spreads to others of that language, with the result that the system develops a strong temporary bias to use items from that one language rather than a random selection of items from the different languages.

But while this leading idea is also found in MCF, it is executed in the context of theoretical assumptions that differ considerably. BLINCS assumes, first, a non-modular mind while modularity is at the heart of MCF. Second, Shook and Marian (2013) attribute the segregation of items in terms of languages to (unsupervised) learning mechanisms. In contrast, a fundamental principle of MCF is that there *are* no learning mechanisms; given APT, none are needed. When two items appear together (a product of perceptual processing), the combination lingers afterwards; if it appears again its resting level rises. Thus, the segregation, if one can call it that, is a natural consequence of processing experience.

An additional, and important, similarity between the approaches is that both BLINCS and MCF avoid the need for language tagging. The two approaches thus provide an interesting demonstration of how, while differing in their fundamental views on cognition in general, they nonetheless come up with some similar solutions for explaining aspects of bilingual processing.

7.5 Conclusion

This is by no means a complete survey of theories of language control (see for example Costa & Caramazza, 1999; Kroll, Christoffels, & Bajo, 2013; Li & Farkas, 2002). The goal has been rather to show how our approach resembles and differs from some prominent existing approaches. For this purpose we picked out a few prominent examples.

8. Conclusion

In this chapter we have explored the role of goals, value, and emotion as cognitive controllers and, especially, as language controllers. Each of these elements of inherently internal context, by its nature, exerts a strong and pervasive influence on language processing, including language 'selection'. In the following chapter we will extend the discussion to the most complex and perhaps most interesting of the elements of inherently internal context – self, in its various manifestations. This will be followed, in Chapter 9, by some applications of the approach to various issues in bilingual processing, centered on the phenomenon of crosslinguistic coactivation.

CHAPTER 8

Control as inherently internal context

Part II. Self as controller

1. Introduction

While people clearly change over time and from situation to situation, there is no doubt that an individual's character and behavior show a high degree of coherence and stability. These features certainly characterize linguistic behavior, however dynamic and variable that behavior might seem. This relative coherence and stability suggests that there is something underlying the behavior which, while subject to change, *is* relatively coherent and stable. In other words, there is in some sense a self underlying behavior, including linguistic behavior.

In the literature – a variety of literatures, in fact – self has been treated as in effect a controller, exerting strong and pervasive influences on cognition and behavior. Examples are memory (Conway, 2005), including false memory (Greenwald, 1980; Ross, 1989), the contents of consciousness (Baars, 1988), self-regulation (Baumeister, Schmeichel, & Vohs, 2007; Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013; Feather, 1990; Kuhl, 1986; Leary, 2007; Raynor & McFarlin, 1986) and its failure (Muraven & Baumeister, 2000; Wills & Stoolmiller, 2002). In other words, self – a key element of the internal context of processing – is widely recognized as a controller (for additional sources on the significance of self, see Chapter 4; also, Markus & Wurf, 1987; Wiss, 1991).

These sources are consistent with everyday experience and observation regarding the influence of self. We might well go further and say that self is implicitly present in nearly all work on control. Authors routinely speak of the person, the speaker, the mind, etc. as controller. This again is the homunculus problem. Its solution is to analyze this implicit controller in terms of the framework, to treat this type of control as simply a consequence of representation and processing as they are understood within it.

In Chapter 2 we characterized self, as the term is commonly understood, as in effect a schema, involving at least three distinct but highly interactive elements – the goal-based self and the meta-self in CS and the affective self in AfS – each having a strong influence on linguistic processing. We also noted though, based in part on the cognitive literature, that control is primarily about goals. Thus, the goal-based self should be at the heart of any analysis of the role of 'self' in control, the other selves entering the discussion primarily, though far from entirely, in terms of their influence on the activity of CS goals.

In this chapter we will first consider the nature of the goal-based self as controller, including its interactions with the meta-self. We then look at the operation of this high level control in processing, emphasizing the distinction between deliberate – *self-based* – control on the one hand and automatic – *selfless* – control on the other. This is followed by a more brief consideration of the role of the affective self and the extent to which we can meaningfully speak of a unified 'self' as controller. We then examine the idea of an L2 self as it is understood within the framework and conclude by returning to the question, considered in Chapter 7, of how our account is related to existing treatments of control.

2. The goal-based self as controller

Control, in the sense in which it is commonly understood, is again primarily about the influence of goals on processing. But while goal activity constitutes the heart of control, this activity is not simply a matter of individual goals acting in isolation from one another. As described in Chapter 4, goal representations naturally coalesce into a larger representation constituting the goal-based self (or more accurately, selves). This highly composite representation acts as a controller, i.e. selective activator. What this amounts to is that the various goal representations constituting a self representation act in a relatively unified manner to activate representations elsewhere in the system. This creates an especially powerful influence on processing and gives behavior a degree of coherence and stability. An understanding of control thus requires an understanding of the goal-based self and of how goals operate within it.

2.1 The goal-based self and dominance within it

Essential for such an understanding is the idea that activity within a composite representation can be temporarily dominated by one of its component representations. In this case we are speaking of the goal-based self being dominated by a component goal, a synchronization of processing within the self, centered on one particular component. We have already described the global synchronization that constitutes POpS and the global working memory and underlies awareness. We also described local synchronization, within a module, i.e. domination of the store by a single representation. The dynamics of the self case differ somewhat from these types, but all the types constitute a focus of processing around a single highly active representation.

In the MCF, the mechanism behind this synchronization of the self is spreading activation. Once a goal becomes active, its activation can spread to related representations. If this overall influence results in a coherent pattern of activity, we have dominance of the self representation. In other words a goal that is currently dominating the goal-based self shapes other activity to make the self as a whole support it. When activity in the goal-based self is synchronized in this way, it is likely to dominate CS as a whole because of the very high activation levels involved, meaning that other CS activity will then be pushed toward conformity with it. In other words, conceptual representations that are related to the dominant goal will become more active at the expense of unrelated representations. Figure 8.1 illustrates domination of the goal-based self and its general influence on CS processing.

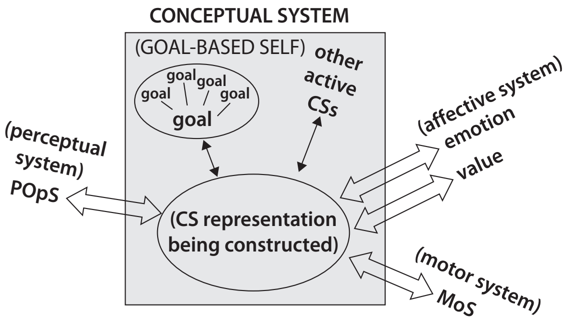

Figure 8.1 The influence of internal context with a dominant goal in the goal-based self

A dominant goal of this sort is the person's current *intention*. If the goal of eating a piece of cheesecake, for example, is currently dominant, this means that the person has the intention of eating one, that goals associated with this intention are active, especially the subgoals involved in achieving the primary goal, and that unrelated goals have only relatively low activation. The cheesecake-eating goal might also activate a goal of refraining from eating it, resulting in a competition between the two goals for dominance of self. The winner then becomes the person's intention. Its victory might turn out to be ephemeral, as the internal contextual support for the two options can shift. If there is no current domination within the goal-based self, the person has no current intention and is not trying to accomplish anything in particular at the moment. This is not to say that no goals are active or that they are not exerting an influence on processing, simply that no one goal is currently dominant.

2.2 The goal-based self as language controller

The goal-based self is composed of goals, so discussion of its role in control is to some extent an extension of the discussion of goals as controllers. As in the case of cognition in general, it brings a degree of coherence and stability to linguistic processing and linguistic behavior. In the discussion of the goal-based self above, a prominent role was played by the idea of dominance of the self by a particular goal representation, allowing that goal to in effect recruit the self representation as a whole. This dominance greatly enhances the impact of the focused goal on current processing and thereby on behavior, including linguistic behavior. As the goal-based self is at the heart of everything that will be considered in this section, we will make only these introductory comments at this point and defer more detailed discussion.

3. The role of the meta-self

In addition to the goal-based self, the conceptual system also contains the meta-self (see Chapter 4), constituting the person's concept of him/herself. As an important, frequently used representation, it is certain to have a high resting activation level, if not so high as that of the goal-based self. As a result, it inevitably exerts a significant influence on processing; i.e., it has a control function.

3.1 The meta-self in cognitive control

Specifically, the conceptual processor often has to reconcile other active representations with the meta-self as part of the normal processor function of establishing a single legitimate active representation from any active representations in its store. Consider the case of a student whose meta-self includes the belief "I am a good student" but who then does poorly on an important test. Assuming that representations of the belief and of the failure are active simultaneously, as is likely, the conceptual processor seeks to reconcile them. This will often mean constructing a representation of the event that is consistent with the demands of the meta-self. Such a representation could take the form of an idea that the test was unfair – there is no incompatibility between "I am a good student" and "I failed a test that was unfair". Failure might also be attributed to lack of sleep or insufficient time to prepare or a misunderstanding of what was to be covered on the test. In each case conflict with the active meta-self is avoided.

Cases like this, in which events are interpreted in terms that make them compatible with the meta-self, are ubiquitous. The demands of the self are, for instance, a major source of false memories (see Greenwald, 1980; Ross, 1989). In our framework such phenomena are simply the normal workings of a processor when it has to deal with two incompatible representations.

Another possible response to failure on the test is to adjust the meta-self, i.e. construct a new representation expressing a lower self-judgment. The original 'good student' representation would not disappear, so the result would be a competition in subsequent processing between the two. More to the point, the processor has again reconciled the originally conflicting representations by altering one of them; but this time it is the meta-self representation that gets altered.

These two possibilities – adjusting the perception of the event and adjusting the meta-self – represent relatively simple accommodation of a new representation, namely the information that the student did poorly on an important exam. A third possibility is that the conflict will lead to a more active sort of control, namely the construction of a goal representation, specifically of the goal of becoming a good (better) student. This development would be natural, given the above discussion of how goals form, because the state expressed by the original representation was valued and a representation of its non-existence is now active. The creation of this general goal might or might not lead to construction of subgoals related to means of achieving it, goals like studying more or asking questions in class. If these subgoals are constructed, they in turn could lead to construction of still more specific goals, of studying at particular times or in particular ways, for example.

As this example suggests, the meta-self is not, in itself, a direct controller of action, at least not a major one. Its control over action is via the goal-based self, on which it almost inevitably exerts a strong influence, by triggering the creation of new goals, as in the example just considered, and by activating existing goals. In the example, the goal of studying more, along with its various subgoals, might already exist, the effect of the failed exam being to activate it rather than create it.

The extent to which demands of the meta-self shape goals and their activity (and probably to a lesser extent, goals shape self-concepts) is the extent to which we can speak of a unified 'self' in CS. The framework does not provide a ready answer, more a way of framing the question. Below we will extend the discussion to the affective self.

3.2 The meta-self in language control

The meta-self can also exert a significance influence on language processing. Since the dominant factor in comprehension is typically the sensory input, the most important influences of the meta-self are in production. Here its significance lies in its influence on the CS representation that constitutes the message to be expressed. Its effect is to discourage the construction of a message that conflicts with the meta-self, particularly the currently active portions of it. If such a message *is* expressed in speech, the processor might immediately cancel its internal impact by combining it with a representation that marks it as untrue, whether or not this new representation is then expressed. In this way the conflict with the meta-self is brief.

The meta-self can have an important indirect effect on linguistic processing via its influence on goals and the goal-based self. The need to maintain face, for oneself and for the interlocutor, can have dramatic effects on the way a conversation proceeds, for example. Similarly, if CARING PERSON is part of the meta-self, its activity can result in the activation or creation of goals of acting like a caring person. This will naturally include goals of speaking like a caring person. Such goals can then influence both the message being constructed and the manner in which it is expressed.

They can also help to determine the use or non-use of one of the bilingual's languages. When a Mandarin-English bilingual in a Mandarin-speaking country encounters a person with limited ability to understand the local language, the goal of expressing the CARING PERSON component of the meta-self can lead to a use of English that might not occur if the meta-self did not contain this representation. For many bilinguals the meta-self includes the idea of being a good speaker of an L2. Activity in this component of the meta-self can result in establishment or activation of goals of showing the ability, leading to a greater likelihood of using the L2, possibly including frequent code-switching. The opposite type of goal could result from a bilingual's belief – in the form of a component of the meta-self – that he/she does not speak the L2 well, leading to avoidance of the language.

4. Self-based and selfless cognitive control

When a goal dominates the goal-based self, and therefore CS as a whole, it exerts a strong influence on processing throughout the system, pushing activity elsewhere into conformity with it, in effect pressuring other modules to carry out the goal. This is self-based control. As the dominant goal constitutes the person's intention, it can also be called deliberate or voluntary control. Selfless, automatic control is simply the absence of this unified dominant influence. Processing is then controlled by the other elements of internal context, without strong involvement of self. In this and the following section we will develop these ideas, first for cognitive control in general and then specifically for language control.

4.1 The nature of self-based control

We suggested in Chapter 6 that an open issue with cognitive control is exactly how the idea of deliberate, voluntary control fits into it – what is voluntary control and under what conditions does it occur? The discussion of control as internal context, particularly of self as internal context, suggests a way to understand and study these issues.

Goals, essential elements of internal context, are by nature purposive. Thus any thought or action that follows from an active goal can, in principle, have a deliberate, voluntary character. But each person has a vast number of goals, and an action based on one goal may be inconsistent with others and simply irrelevant to the vast majority, making its fulfillment a very limited and uncertain sort of voluntary action. The interesting case is when a great many goals are organized into a relatively stable, coherent structure and this structure is currently dominating processing. Under these circumstances, thoughts and actions that result from this dominant influence can have a truly deliberate character; they are what *I* am doing. This stable, coherent, and highly active goal structure is, of course, a self representation.

In this perspective, actions or thoughts that result clearly, directly from the influence of a self representation are perceived as volitional; and this can reasonably serve as a definition of the term. One implication is that the involvement of a self representation is strongly associated with control but is not a necessary condition for it, as other elements of internal context can guide processing in the absence of a dominant self influence. A related implication is that borderline cases and misperceptions should occur. Borderline cases are those in which a thought or action results in part from self activity but other factors also play a significant role. These cases can easily result in a misperception that the thought/action was purely volitional (i.e. in the construction/activation of a representation of that idea). This sort of misperception shades into self-deception, probably quite often (see Wegner, 2002). This amounts to the construction or activation of a representation of the idea that the thought/action was volitional, based on the influence of highly active self-esteem goals that are prominent components of the self representation.

In the discussion of self in Chapter 4 we said that a single person need not, and almost certainly does not, have only a single goal-based self representation. Different situations, involving different contexts and different goals, lead to the establishment of multiple overlapping self representations. This point dictates an adjustment in the suggested definition of voluntary: Volition is not simply about *a* self representation but rather about a self representation that is currently dominating CS. A thought or action is voluntary if it is a direct consequence of activity in a currently dominant goal-based self representation.

The existence of multiple self representations creates the possibility of conflicts and switches. When one such representation is dominant in a situation, another representation might be briefly activated – probably by bottom-up influences – to the point that it produces an action inconsistent with the first. An utterance made during this switch in dominance (or perhaps shared dominance) might subsequently be repudiated – "I don't know why I said that" or "That wasn't me". The extreme case is Dissociative Identity Disorder (Multiple Personality Disorder), in which there is only limited overlap between selves. Under these circumstances, when one self is dominant the person may have no sense at all that an action carried out while another self was dominant was his or her action, and might have no memory of the act.

Implicit in this discussion is the association between volition and consciousness. A strong sense of volition in a particular act implies that the activity in the goal-based self is synchronized with that in the representations involved in the act. This in turn implies a high level of activation throughout and therefore awareness of associated perceptual representations, where the highest of the high levels are found. We will return to such issues in Chapter 11.

The appeal to self representations as the source of voluntary control does not automatically eliminate the familiar danger, that the entity we have hypothesized in order to explain control will be treated as a homunculus, a treatment that would remove its explanatory value. This danger is greatly reduced, though, by the fact that self, as understood here, is a representation, occupying a specific place in a relatively explicit architecture and not differing in any fundamental way from other representations in its character or in its participation in processing. The composite nature of a self representation is also relevant. Its influence on processing reflects the goal representations of which it is composed, their activation levels, their organization within the self representation, and their connections to representations in other modules, notably value in AfS. We have not tried to give anything like a full account of these complex matters. Our proposal is thus not a theory of self or of voluntary action but rather a framework for development of such theories. Development can be guided by the extensive existing literature on the nature of self, importantly including neuroscientific work, briefly reviewed in Chapter 4.

4.2 The process: Dynamic shifts in control

When activity in the goal-based self is synchronized around a particular goal, the result is an especially high activation level for that goal representation and an accompanying ability to strongly influence – 'control' – processing elsewhere. But control cannot be a simple matter of one goal dominating processing. Shifts in control are common and essential. Carrying out any but the very simplest of goals involves a number of subgoals, each of which must in its turn act as controller. Thus shifting routinely occurs between goals within the goal-based self, and also between self-based and selfless processing.

4.2.1 *Control in trouble-free processing*

During execution of a high-level goal, dominance of the goal-based self necessarily shifts from that goal to lower-level subgoals and sub-subgoals and among the various subgoals and sub-subgoals. At times the shifts might be by way of the high-level goal, in effect coordinating the activation of the lower-level goals. This main goal is likely to retain significant activation throughout the task, though dramatic variations in its level should occur based on whether it is or is not dominating self at the moment. When a goal is achieved, this success will undermine its activation and therefore its dominance of the goal-based self, because an inherent part of a goal representation is the concept that the target is not actual. When this 'unrealized' component of the goal representation is no longer active, the goal itself will lose its activation and its ability to dominate the self. This applies to the main goal itself and to all the subgoals involved in executing it. When a subgoal is achieved and therefore loses its dominance, control naturally passes to another subgoal or back to the overall goal.

Overall, this is self-based control, as processing is consistently based on the goal representation that dominates the goal-based self, which can be either the initial, overall goal or one of the lower level goals involved in carrying it out. But some elements of the processing are likely to be automatic, operating without control from self. The act of ordering a slice of cheesecake at a coffee shop, for example, is likely to include routine movements to the counter and formulaic speech once there. Neither requires involvement of the self – they are automatic processes.

Within the framework, automaticity of a task simply reflects the existence of appropriate representations, appropriately interconnected, and with sufficiently high resting activation levels in the representations themselves and in the indexes connecting them; in other words, a well-established schema. When these conditions are met, activation of part(s) of the schema can trigger a sequence of activations constituting execution of the automatic routine. The trigger could be activity of any element of internal context, most likely a combination of outside-in context and inherently internal context. The goal of obtaining the cheesecake, possibly dominating self, is of course important for the triggering, as is the value associated with the cheesecake, but also important are representations of the layout of the coffee shop and the person's current location in it, along with the presence of other people.

These outside-in contextual representations are likely to dominate CS at times during execution of the goal, as a result of their association with perceptual representations that have been strongly activated, probably as part of a relatively spontaneous POpS synchronization (see Chapter 6, Section 3.2.3). In such cases we have selfless control, operating as part of the overall process of achieving a goal. This is not to say that self is inactive or that the processing is contrary to self (though this is a possibility), simply that processing is currently being shaped by other aspects of internal context.

4.2.2 *Control with complications*

Variable dominance/control is a natural part of the smooth, trouble-free execution of a dominant goal. But it can also be a consequence of complications that arise in the execution of the goal. These complications can come from difficulty involved in achieving the goal, competition among rival goals or subgoals, and the degree to which the current goal does or does not receive continuing support from other contextual elements.

Difficulty, of course, can prevent or delay achievement of a goal. The active goal representation activates representations that do not lead to its achievement, possibly because of the absence of a suitable schema or of connections between it and the goal. This is in effect a failure to pass the task on to appropriate subgoals. Dominance could thus remain with the main goal when it should not, or could pass to other goals that are not appropriate for the task. Complications can also come from the activity of opposing goals. A goal of eating a piece of cheesecake can be challenged by a goal of losing weight, with the natural subgoal of avoiding the cheesecake. This latter goal could come to dominate self – become the person's current intention. Recurring shifts of dominance between the two goals can also occur; experientially, this is uncertainty or variability in what the person 'really' wants to do.

Continued dominance of a particular goal and its subgoals, long enough to achieve the goal, is also dependent on continued support from contextual factors, especially outside-in context. If this support disappears or is greatly weakened, activation levels will drop and dominance is likely to be lost. If, for example, the person is told by a companion that the cheesecake in this particular establishment is of low quality, or remembers a bad experience with cheesecakes here, the result can be a change in the value currently attached to the cheesecake, undermining the support for the goal of eating it and possibly creating or activating a goal of avoiding the cheesecake, which could then come to dominate self.

As this point suggests, the influence of outside-in context often amounts to competition among goals. The immediate, direct influence of the bottom-up factors is to activate any CS representations with which they are coindexed. These might include other goal representations. They might also include components of such representations, which will then activate the alternative goal, or representations that share features with that goal, in which case the activation will spread to the goal via these common features. In any case, the result is activation of other goals, which then compete with the original goal. Thus the cases of outside-in context opposing a goal can often be analyzed as competition within CS between the original goal and one or more newly activated goals. The essential issue is then which, if any, of the goals come to dominate the goal-based self representation.

4.2.3 *Value and emotion in self-based and selfless control*

Goals and their activity are inseparable from value and emotion. A Japanese learner must in some sense value the learning of Japanese or else there would be no goal of learning it. The value could be attached to the language itself, to the culture, to the practical benefits of speaking the language, or to any number of more idiosyncratic factors. But if there is no value then there is no goal, and no attempt at learning. And the greater the value the more seriously the learning process will be taken – value acts as a booster, raising the activation level of the goal. Specific emotions can also be associated with a goal, as described above.

These AfS influences can give the goal the activation level it needs to establish dominance in CS and then to overcome opposing influences, such as a desire to spend time on easier and perhaps more enjoyable activities. In other words, a goal that is highly valued by the person or evokes strong emotion is more likely to be kept active in the face of opposition. On the other hand, affect can also strengthen the opposing influences, as when the potential enjoyment of watching a movie challenges the goal of spending time on Japanese study.

The most extreme influence of affective factors, either in support of or in opposition to the active goal, comes from the AfS self, due to its dominant position in AfS and the extreme activation levels it routinely reaches. If this representation is synchronized for a time on a particular emotion that opposes the current goal (the happy thought of watching a movie or the feeling of boredom associated with studying), maintenance of the goal in the face of this opposition requires strong involvement by the goal-based self, probably with considerable support from other sources. The result is thus likely to be abandonment of the goal. We will return to the affective self shortly.

4.3 An example of self-based and selfless control

Consider the case of a person trying to write a paper at a coffee shop while a conversation is going on at the next table. First, "trying to…" indicates an intention, which means that a representation of the goal of writing the paper dominates the goal-based self and therefore CS as a whole. This goal is highly active, its activity supported by the value presumably attached to it and then by the general activation of self around it, pushing the system in general to a focus on its achievement.

The dominance of the general goal alternates with that of its subgoals and the outside-in representations involved in its execution. Subgoals range from writing a particular section to adjusting the organization to expressing a very specific point. Much of the processing is automatic (selfless), using established schemas of familiar perceptual and motor processes in service of the overall goal and its subgoals. Throughout the process POpS will be dominated by visual and often auditory representations of what has been written, giving strong activation to the conceptual representations associated with them, i.e. the meanings of the words, which are therefore likely to dominate CS at various points. We will not be concerned at this point with what is going on in the linguistic modules during this process, a topic we will take up in Section 5.

The nearby conversation is a potential diversion from the paper-writing goal, constituting sensory input that encourages activity which is inconsistent with that goal. POpS synchronization focused on the auditory input can itself interfere with the self-based processing, as awareness of the conversation replaces awareness of the words in the paper. The synchronization can also lead to activation of CS representations (conceptual analysis of the input) that compete with representations involved in achieving the goal. This bottom-up, outside-in influence could well win the competition, momentarily or lastingly. This would then be a case of selfless control.

The success of the outside-in distracters in the competition depends on the current activation levels of the CS goal representations. If the paper-writing goal is very active and consistently active – the person is very focused on the writing – it will maintain the intended POpS synchronization and prevent the auditory input from establishing the bottom-up synchronization, at least most of the time. This strong, persistent activity will probably owe much to AfS influences, particularly to the value associated with writing the paper – how much the writer cares about the task. This influence contributes to the activation of the goal and therefore to its domination of the goal-based self.

Whether the self-based processing continues smoothly or is interrupted also depends on the activation levels of the opposing influences, namely the bottom-up influences created by the neighboring conversation. Suppose someone at the next table mentions the person's own name, for example, or uses an offensive term, or talks about a subject that is particularly important to the person. This input will activate representations that are highly valued and/or have very high resting activation levels and therefore could well become the focus of the global synchronization, with inevitable effects on activity in CS as well. The result would be a loss of dominance by paper-writing goals and therefore an interruption in the task of writing. Similar effects could be produced by a particular tone of voice or a sudden rise in volume. If, on the other hand, the conversation contains nothing of interest to the person then any perceptual or conceptual representations that result from it are unlikely to be sufficiently active to compete with self activity in establishing/maintaining the desired focus.

External factors are by no means the only influences that can oppose the self's focus, though. Other conceptual activity is always present, at varying levels of intensity, and such activity always has the potential to yield a rival focus, particularly if it is associated with strong affect. Possible examples are thoughts of financial problems or of a recent quarrel with a family member. Representations of these things could well acquire current activation levels sufficiently high to become the focus of the global synchronization. This is particularly true if the intended focus includes at some point a representation closely related to one of these potential rivals (a reminder of the problems), thereby further increasing its current activation level. In such cases the focus will only be maintained if the self's influence is especially strong.

Suppose, on the other hand, that the person is currently taking a break from the work and so is not trying to do anything in particular at the moment. This is to say that no particular goal representations are currently dominant in CS. In this case the auditory input can easily yield a spontaneous, selfless focus on the conversation. In other words perceptual and conceptual representations of the conversation will dominate their modules, participating in a broad synchronization focused on it, and this synchronization will occur with relatively limited involvement of self.

4.4 The use of metalinguistic knowledge as self-based processing

In the second language acquisition literature, the role of metalinguistic knowledge as 'conscious knowledge of language' has been a live issue since its inception (Krashen, 1976; Sharwood Smith, 2004; Truscott, 2015a). Krashen defined what we are calling metalinguistic knowledge in terms of consciousness, a topic that we will turn to in Chapter 11. Here our concern is with another key aspect of this kind of knowledge, the deliberate nature of its use, what Krashen called monitoring. This deliberate use, in the MCF, is an instance of self-based processing.

If the model of the mind that is suggested by the framework architecture is on the right track, Krashen's original assertion that metalinguistic (consciously learned) knowledge of grammar is qualitatively different from the grammatical knowledge that underlies spontaneous language performance is essentially correct. Fluent spontaneous use of language depends on the automatic processing of the linguistic modules, and the metalinguistic knowledge found in CS and encoded in conceptual terms is something entirely distinct. It should be expected to play only a limited role in language performance, as Krashen has always maintained.

However, a more nuanced approach to metalinguistic processing would have to include the possibility that it can become skilled. That is to say certain CS-based grammatical routines whereby selected constructions in a language that are recognized by the individual as problematic can be deployed in fluent performance in such a way as to give outside observers the impression that they are part of the individual's implicit syntactic or phonological knowledge. This would be relatively selfless use of metalinguistic knowledge. Much anecdotal evidence from language users 'admitting' metalinguistic activity undertaken during their apparently fluent L2 performance would seem to suggest interesting research can be done in this area to establish the limits of metalinguistic processing on grammatical performance, which would still appear to be limited but not as much as implied by Krashen's original Monitor Model (Sharwood Smith, 2004). Within the framework, we can also ask to what extent such use can become truly selfless.

It should be noted in passing that L2 users and any bilingual who happens to feel continuing concern about the accuracy and/or communicative effectiveness of their language performance will tend to be more metalinguistically active when performing. This implies activity in GWM and, by extension, in neural systems associated with executive control. Whether or not this activity has any observable effects on bilingual performance, the effects of metalinguistic activity are likely to show up in experimental findings using imaging, ERP and response time techniques. When working out the theoretical implications of any differences observed in the data between participant groups, the possibility of metalinguistic effects showing up in the data needs to be taken into account. Metalinguistic activity may for example have a distracting effect masking essential similarities between monolinguals and bilinguals with regard to the specific topic under investigation.

Krashen has maintained that metalinguistic activity may even have an inhibiting effect on the L2 acquisition process making a learner less open to the clues available in the input which should be processed intuitively: This is when they devote too much time to self-correction and generally trying to be as native-like in their performance as possible. Ideally a language learner, in his opinion, should concentrate completely on meaning, that is on communicating, and should not pay special attention to and worry about formal accuracy. Initially his focus was on grammatical accuracy alone but his views on how a learner should approach the use of an L2 seem to include vocabulary, i.e. lexical accuracy as well (Krashen, 1989). Even though more advanced learners may as we have suggested become metalinguistically skillful in combining intuitive and reflective use of the L2, this proposed inhibitory effect may still apply where grammar is concerned. However, this is less clear with regard to lexical aspects of language which, in MCF terms, also implicate representations outside the core language system, especially CS.

5. Self-based and selfless language control

Above, we characterized self-based (volitional) control in terms of dominance of the goal-based self by a particular goal representation, which then pushes processing in general toward execution of that goal. Selfless control, which can also be called automatic, is then the absence of this unified dominant influence – processing is controlled by the other elements of inherently internal context, namely goals, value, and emotion, on the stage set by outside-in context. Our concern now is how these ideas apply to bilingual language control.

5.1 The nature of self-based language control

Language production begins with the construction of a message representation in CS, the activity of which stimulates coindexed SS representations. The message construction process is based on all the factors of internal context. Figure 7.3 of the previous chapter depicted this situation in regard to the influence of goals, value, and emotion. Now we must add the goal-based self. If an active goal has come to dominate the self representation, the self will then exert an especially strong influence toward the achievement of that goal – the goal will be what the person *really* wants to do. In this case we are talking about shaping the message representation in accordance with the dominant goal. The situation is depicted in Figure 8.2.

The goal-based self (the uppermost oval shape inside the conceptual system box) consists of subgoals, in smaller text, and one dominant goal, in enlarged

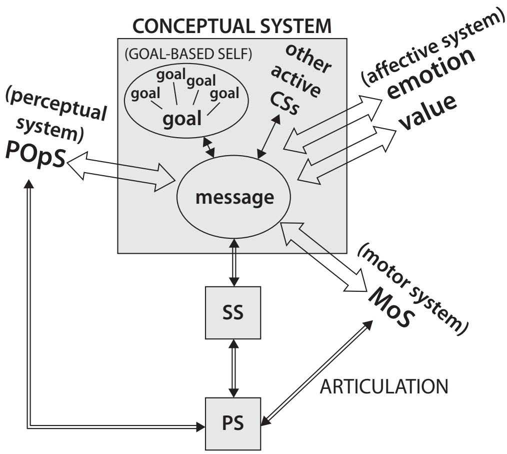

Figure 8.2 Contextual influences on construction of a message representation, with a dominant goal in the goal-based self

text. Affective, perceptual and motor systems represent the factors outside the conceptual system itself which also help to shape the message. The message itself (the lower oval shape) will typically be a complex conceptual representation. This in turn is associated with a particular linguistic set of (syntactic and phonological) representations (in the two smaller boxes). The dominant goal here might be to express a particular idea or to use friendly, deferential language or, most interestingly, to use one language rather than the other.

The contrast between Figures 7.3 and 8.2 illustrates the two general ways in which a bilingual can come to use one or the other of his/her languages in a given case (i.e. how a language is 'selected'). When there is minimal involvement of the goal-based self (Figure 7.3), and the language used is instead controlled by the combination of bottom-up, outside-in context and the other elements of inherently internal context – goals, value, and emotion – we have automatic or selfless control. When the goal-based self is largely responsible (Figure 8.2), we have what can be called self-based or volitional control. In this case we can say that the person has chosen to speak one language rather than the other.

In its most explicit form, this decision to speak a particular language makes use of the language representations in CS. When the goal-based self is dominated by an explicit goal of speaking English, for example, this goal necessarily includes the representation ENGLISH. This representation is likely to be contained in a large number of other CS representations, constituting the meanings of English words and expressions, simply because it has been active at the same time as those representations during processing experience. So activation of the language representation spreads to many representations that can be used in speaking English. The existence of language representations thus allows a degree of deliberate, conscious control. The situation is shown in Figure 8.3.

When the concept HAPPY is to be included in an utterance, if ENGLISH is currently active along with it then HAPPY+ENGLISH will get an extra boost in its activation, making it more likely to participate in processing, at the expense of

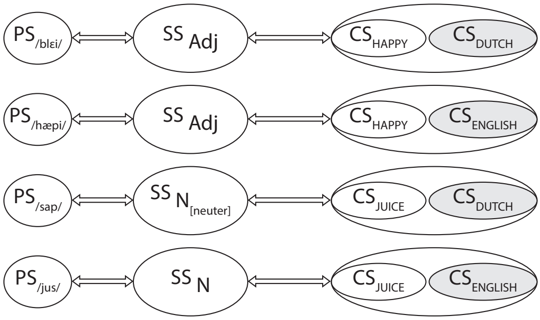

Figure 8.3 Active language representations help to determine which language is used

HAPPY+DUTCH. Thus 'happy' is likely to be used rather than 'blij'. If ENGLISH remains active throughout the construction of the message, this influence will be a general one, encouraging the production of an English sentence. This effect is enhanced, probably greatly enhanced, by active SS and PS frames which, as described in Chapter 6, are likely to consist overwhelmingly of English items.

In this scenario it is quite likely that the goal-based self is playing a prominent role, i.e. that it is dominated by a goal of speaking English. In this case we can say that the person has decided to use this particular language; it is the current intention. This is self-based processing. But involvement of the self is not a necessary condition for use of the language representation. A natural alternative is that ENGLISH was activated and is being kept active largely by outside-in context, such as representations of the interlocutor and the setting, and the goal-based self has little or no involvement. In this case there is no decision to speak English, but we can still say that it is voluntary based on consistency, or at least lack of inconsistency, with the goal-based self.

Given this importance of outside-in context, the use of English rather than Dutch does not require involvement of the language representation, ENGLISH. We referred in previous chapters to Grosjean's (2010, 2016) Complementarity Principle, the observation that the different languages of a bilingual tend to be used in distinct situations, with distinct people, for distinct goals. In our terms, a great many CS representations of goals and context have become associated with individual words and other items of one particular language, that is to say with the CS representations that serve as the meanings of those items. When any of these goal representations or contextual representations is active, its activation will thus spread to these meaning representations and then to the entire CS-SS-PS chains of which they form the head. The implication is that when the person is in a particular situation or talking to a particular person or speaking in service of a particular goal, one of the two languages is automatically favored because of the influence of these factors, independent of any deliberate decision or of metalinguistic knowledge of the distinction between the languages. This point is illustrated in Figure 8.4.

This is the case of a child growing up in a Dutch-speaking community with English as the home language. Certain English words, such as 'bedtime' and 'hug', are used predominantly in the home setting and so their meanings (CS representations) will be associated with HOME, simply because the latter is active when these words are used. Similarly, the Dutch words 'pauze' (break) and 'juf' (a female teacher responsible for young children) will be used primarily in the school environment and so the CS representations will become associated with SCHOOL. The result is that the child is likely to use the English words in the home and the Dutch words in school. In such cases there is no need for any overt marker

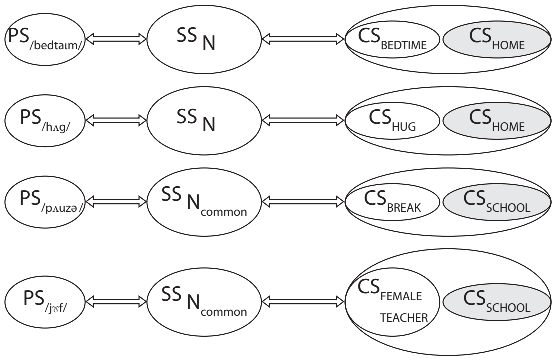

Figure 8.4 Outside-in context helps to determine which language is used

of Dutch or English. Context can determine which language is used, without any reference to the appropriate language as such.

In this example the relevant external context is the physical setting. But it can also include a variety of other factors, notably the interlocutor(s). In the broader sense of context that we are using, goals should also be included as important factors. A child's goals in carrying out school tasks or in talking to peers frequently differ from his/her goals in talking to family, and so the goal representations can also become associated with one language or the other and, once the connections have been established, influence the choice of language.

The character of the language system is also important here, as above. Once some English representations have become active their activation naturally spreads to the frames in which they are included and then to other, typically English, representations within those frames. The result is likely to be an utterance that is primarily if not entirely English.

5.2 Some examples of self-based language control

An example of self-based control can be found in the case, considered above, of a child who develops a very general negative attitude toward the heritage language and is unwilling to speak it even in the context in which it is clearly appropriate – the home. This unwillingness to speak the L1 is controlled primarily by negative value associated with the language, when that association is not limited by representations of particular contexts in which the L1 is considered undesirable. The only way this avoidance is likely to be overcome is by self-based control: The goal-based self comes to be dominated for a period of time by a goal that involves speaking the L1. This dominance would be a product of strong activation of representations that support the goal, based on the value associated with them. Likely examples are respect for family, desire for harmony, and desire to escape from parental pressure or censure.

If such factors do result in dominance of a goal of speaking the L1, L1 use then becomes the person's intention. If that intention is maintained – the goal continues to dominate the self – it will control behavior. But its domination is likely to be constantly challenged by the negative value associated with the L1, which supports goals of avoiding its use. Behavior is then a question of how this competition plays out.

Another type of case involves language anxiety. In the discussion of emotion as language controller, we briefly referred to the way that anxiety can inhibit use of a given language. Goals of minimizing the anxiety by avoiding such use compete with whatever goals or other activity are encouraging its use. If the avoidance goals win the competition and come to dominate the self, the person's immediate intention is then to avoid using the language, to find ways to get around the need to use it, or perhaps to deny the need. The goals of using the language then constitute opposition to the intention. If, on the other hand, the goal of using the language dominates the self, becoming the intention, then the anxiety constitutes an obstacle to execution of this intention, activating representations that conflict with those needed for its execution. How this conflict plays out, immediately and in the long run, determines whether the person will use or avoid the language. In any case, this is very much a matter of the goal-based self acting as controller.

5.3 A more extended example

These points can be better understood through more in-depth consideration of an example of self-based and selfless control. The case we will explore is that of an English class in which students share a common L1 but are expected to use the L2, English, in class. In such a case there is a natural tendency for them to use their L1 in talking to each other, because very strong associations exist between representations of the interlocutors and L1 representations, which also have high resting activation levels. Here the bottom-up, outside-in factor of interlocutor identity opposes the active goal of speaking in the L2. A student's use or non-use of English is determined by how the competition between these and related factors plays out.

Consistent use of the L2 naturally depends to a considerable extent on how strong (active) the goal of speaking it is. This in turn depends on the goal's current dominance of the goal-based self. If this very active representation is continuously involved in maintenance of the goal, abandonment of that goal would only occur if the opposing influences are extremely strong. What this strong involvement of self amounts to, intuitively, is that the person really wants to fulfill that goal and so might perceive abandonment of it as a failure rather than just a change of plan. Without this self-based control, the outside-in factor of interlocutor identity could well control processing, resulting in use of the L1 despite the (insufficiently active) goal of using the L2. This is automatic, selfless control.

A number of additional factors are important as well, each either supporting the English-using goal or opposing it. One is the relative strength of the two languages. For nearly all students in an English class the L1 is considerably stronger than the L2, meaning that activation levels of L1 representations have much higher resting activation levels and their connections, to each other and to contextual representations, are more developed and have higher RLAs as well. This imbalance naturally favors use of the L1. In more familiar terms, a person who needs to communicate in a foreign language but has limited ability in that language might experience an automatic tendency to revert to the L1. Continued use of the L2 despite this urge is likely to reflect deliberate, self-based control.

As this suggests, the goal of successful communication can work against consistent use of the L2, i.e. against continued dominance of the self by the goal of using it. Students engaged in a communicative task might find that they need to express a message that is very difficult for them to express in the L2. The communication goal then supports use of the L1, especially if the task is a particularly engaging one to them.

Additional contextual factors can support the English-using goal. The classroom setting activates the person's knowledge and beliefs about the class and about proper behavior within it, which are likely to support the English-use goal. Also active, to varying degrees, are the goals related to the class and the student's participation in it. These goals will presumably vary somewhat with the individual and the situation but are likely to include such things as gaining experience in the L2, carrying out an assigned task, pleasing the teacher, fulfilling commitments made in enrolling in the class, and impressing classmates. These factors will typically support the goal of consistently using the L2.

Thus, a number of factors interact and compete for control of processing and therefore of behavior. A frequent result of these conflicting influences is shifts in dominance of the goal-based self and therefore in behavior. The use-English goal could be replaced at any point by a goal that involves use of the L1, such as successful communication. While this new goal is dominant it is the person's current intention and the goal of speaking English is then an influence opposing that intention. It might well be successful in this opposition, becoming dominant once more, especially if it is reinforced by outside-in contextual factors like encouragement from other students or a request from the teacher to speak English, or perhaps simply the teacher's presence nearby. This reassertion of the original goal could also result from shifts in the immediate task demands – the message to be expressed at this point does not pose any great challenges to the student's English skills. In this case the communication goal no longer supports the use of the L1, allowing the original goal to reassert itself.

We do not want to give the impression that the speak-English goal continually dominates the self when English is being used, though this may be a useful abstraction. During language use the self is most often dominated, if at all, by lower-level goals involved in speaking and in comprehending others' speech, with the goal of speaking English waiting in the wings, i.e. still quite active and potentially dominant but not currently dominating. When a learner reverts to the L1, this shift is probably most often a product of selfless control, made possible by the absence of a contrary influence from the self, rather than of a switch-related goal coming to dominate the self. In more familiar terms, the use of the L1 is not deliberate in such cases but rather comes naturally when there is no clear intention at the moment to avoid it.

The role of affective internal context in this classroom example, and in self-based and selfless processing in general, deserves some explicit discussion. The first thing to note is that goals are by nature valued. In other words goal representations and their components are coindexed with value in AfS. The degree to which a goal is valued is captured in the resting level of the index. If the goal of successful communication is highly valued, this means that the index connecting this goal representation to value is highly active and so contributes significantly to the activation level of the goal and therefore to its potential for achieving dominance of the goal-based self, taking that position away from the goal of practicing the L2. In more familiar terms, this is about the speaker's intention to practice the L2 and the potential abandonment of it in favor of an intention to achieve successful communication, in this case by switching from the troublesome L2 to the shared native language. Value is an important determinant of which goal becomes the current intention and the extent to which the person will stick with that intention.

An important role can also be played by particular emotions, each of which is a representation in AfS containing a value representation. The emotion could be happiness or pride at the idea of successfully using a foreign language, anxiety about making mistakes, pride in ethnic identity that is associated with one of the languages, anger or frustration toward the class, liking or respect for the teacher, or any of countless others. Each can raise the activation levels of one or more goals that affect the choice of language and the likelihood of continued use of the intended language. Note that in all these cases the AfS factors are influencing linguistic processing by way of CS; CS is the crossroads where language processing and its internal context come together.

5.4 The case of switch costs

The distinction between self-based and selfless processing can also be seen in findings from the study of *switch costs*: the extra time needed by bilingual subjects to respond when a task requires a change from one of their languages to the other (see Grosjean & Li, 2013; Hoshino & Thierry, 2014; Jiang, 2015; van Hell, Litcofsky, & Ting, 2015). The research in this area was based on designs that were developed outside the field of bilingualism (Rogers & Monsell, 1995), but it has become a prominent part of the field.

A good place to start in discussing switch costs is with the question of (a)symmetry in switch costs: When the person is using language A at one point and then switches to language B, does it matter which of the two is the person's dominant language? Is switching in one direction more costly than in the other? If so, which direction carries the greater cost?

Interestingly, two different answers have been found, depending on the nature of the task. One type of task presents the targets in sentential context while the other presents only isolated words. The first produces the expected result that costs are higher for switches from the stronger to the weaker language (Bultena, Dijkstra, & van Hell, 2015; van Hell, Litcofsky, & Ting, 2015), but in the isolated word condition the contrast is canceled or reversed: Costs are sometimes higher for switches from the weaker to the stronger language (see van Hell, Litcofsky, & Ting, 2015). This seems to suggest the paradoxical conclusion that the weaker language is having a greater effect on the stronger language than vice versa. We will consider here these results and the possibilities for explaining them, from the perspective of internal context as understood in the MCF.

5.4.1 *Factors underlying switch costs*

A great many factors can potentially influence the results of a switch cost experiment. Consider first the purely linguistic factors. Here, as always, resting activation levels are important, especially contrasts between the two languages in this respect. Higher resting levels will mean that the representations are more readily available for processing. Lower starting levels mean that more time and greater stimulation is required for current levels to become high enough for them to compete with representations from the other language. This factor favors, almost by definition, the stronger language.

The other purely linguistic factor is the activation of SS and PS frames that accompanies activation of the target word. Given the familiar words that are used as targets, the prior existence of such frames is virtually certain, based on previous processing experience (see Section 4.2.1 of Chapter 6). If the conditions of the experiment contribute to their activation, they will in turn contribute to activation of the target word. These frames, like the individual words, also have associations with contextual representations, providing an additional source of activation. When present, this factor will also favor the stronger language, because acquiring proficiency in a language entails the development of such frames and their connections to contextual representations, with high resting levels in both cases, making their use relatively automatic. Representations in a relatively weak language will have less developed connections and so receive less support from this source.

The effect of outside-in context in these experiments is more complex and variable, as it involves a number of factors and represents an interaction between the external situation and the individual's prior experience with each language. So these are factors that probably do not consistently favor either direction of influence but instead constitute potential confounding influences.

The inherently internal aspects of bilingual processing are largely removed or fundamentally altered in these designs. The normal goals of language use are replaced by the goal of carrying out the specified task, i.e. saying a particular word in a particular language at the appropriate point. Loss of most of the value and emotion normally accompanying language use follows. The value associated with carrying out the task remains, as does the emotion associated with the target word and with any sentence context that is provided. Also remaining are the contextual connections of the individual target words and any active linguistic frames associated with the sentential context.

Altogether, these factors seem to favor the stronger language, so results of the sentential context condition – higher costs are found for switches from the stronger to the weaker language – are expected. This discussion also implies, rightly, that the stronger language should be less favored, or possibly not favored at all, in the isolated word condition. What differs between the two designs is the linguistic frames and their contextual connections. As these factors favor the stronger language, their absence from the isolated word condition should have this effect. What is not immediately explained is why the weaker-to-stronger direction often entails not just equal but actually higher costs in the isolated word condition. It appears that something else in the design favors the weaker language, either specifically in the isolated condition or in general. The question then becomes what this something might be.

5.4.2 *A hypothesis*

The likely place to look for an answer is outside the language systems themselves, at aspects of the internal context. The dominant aspect of the internal context in these designs is artificially imposed goals: Participants are expected to carry out a specified task, saying a particular word in a particular language. Evidence exists that this factor can be decisive in research on switch costs, that natural, voluntary switching – i.e. switching in the absence of the artificially imposed goals – does not entail any costs and can even be facilitative (de Bruin, Samuel, & Duñabeitia, 2018; Gollan & Ferreira, 2009; Kleinman & Gollan, 2016). A key factor in these findings seems to be that voluntary switching tends to occur when a word in the currently unused language is more readily available than its alternative in the other language.

Thus, the artificial goals imposed by the experiment appear to be what drives bilingual processing and behavior in standard switch-cost experiments, producing a very deliberate variety of switching and non-switching. From the MCF perspective, self-based processing dominates here, in contrast to the relatively automatic, selfless processing that characterizes most of our more natural language use. In neural terms, this should mean that control regions of the brain, essential for deliberate switching, do not play a significant role in voluntary switching, and this is what Blanco-Elorrieta and Pylkkänen (2017) found, using magnetoencephalography.

Further pursuing the MCF interpretation, the experiments' instructions establish two active goals in CS, which then guide performance.

SEEK ((SAY WORD IN L_X) UNREALIZED)
SEEK ((SAY WORD IN L_y) UNREALIZED)

These goal representations must be kept active throughout the task, and the very deliberate nature of the switching and non-switching indicates that during the task they alternately dominate the goal-based self. They thus constitute a very prominent part of the internal context and so must be taken into account in any analysis of the outcomes. In particular, if they differ in their activation levels and/or in their connections to SS, these differences could be crucial for performance.

There is good reason to think that they do differ, in both respects. Use of a dominant language, say L_X in this case, is largely automatic; it is typically used by default unless strong contextual factors go against its use. In other words a *decision* to use the dominant language is very much the exception; it is used spontaneously whenever there is nothing to prevent its use. Thus, before the experiment the explicit goal of using L_X probably had only a low resting level, if it even existed, and any connections it might have had to linguistic representations would have similarly low levels. In contrast, deliberate use is very much in the nature of a weaker language, so the goal of using it is almost certain to already exist and to have relatively high resting levels, in itself and in its connections to relevant linguistic representations. The implication for switch cost experiments is that the goal of using the weaker language will be more readily available and, all else being equal, it will come into play more quickly and strongly and with less effort than the goal of using the dominant language.[1]

This suggests a hypothesis that might account for the paradoxical results of the experiments. In both types of designs the goal factor is encouraging greater

1. For a possibly related approach, but one relying on inhibition, see Meuter and Allport (1999).

activation of the weaker language relative to that of the more dominant language. The presence of a sentential context has the opposite influence and this influence is typically stronger, based on the linguistic and contextual factors considered above, resulting in greater costs in switches away from the dominant language. When the sentential context is removed, the goal factor comes to dominate, producing a tendency for greater costs in switching to the dominant language.

5.4.3 *Conclusion*

We should end this section with a note of caution. The literature on switch costs and related phenomena is rich and complex and the findings are often ambiguous. Perhaps more important than offering a specific hypothesis to explain a specific observation here is placing the issues within an explicit framework in which they can perhaps be more productively studied.

5.5 Interpreting

The approach presented here, with its notions of self-based and selfless processing, offers a possible means of understanding and further studying the processes involved in interpreting. Here we will briefly consider this point, without trying to develop a specific account of interpreting. We return to the topic in Chapter 11, Section 4, in the context of consciousness and internal context.

In the literature on this subject, the notion of executive control is normally called upon to describe the mental juggling operation that is at the heart of the interpreter's task. The feats accomplished by interpreters have in recent years sparked a growing interest in examining the neural and psychological aspects of executive functions in highly proficient bilinguals with and without varying degrees of interpreting expertise (Aparicio, Heidlmayr, & Isel, 2017; Christoffels & De Groot, 2004; Hervais-Adelman, Moser-Mercer, & Golestani, 2011; Köpke & Nespoulous, 2006; Köpke & Signorelli, 2012).

Consecutive interpreting imposes strong demands on processing resources, and still greater demands are made in *simultaneous interpreting*: This is a kind of translation that also requires that the interpreter attend to input in the source language while at the same time having to produce a version of the input in the target language: This effectively means switching very rapidly backwards and forwards between comprehension and production while speech input in the source language continues uninterrupted. In other words, in contrast to consecutive interpreting, there is no break between fragments for the interpreter to construct and produce a translation of the previous stretch of language on without interruption from the speaker.

It is too soon to come to any firm conclusions given ongoing problems in the literature in establishing clearly what the concepts of executive function and working memory exactly entail (see discussion in Oberauer, Farrell, Jarrold, & Lewandowsky, 2016; Sharwood Smith, 2017d). This is a task we have tried to tackle, or begin to tackle in this book. The notions of self-based and selfless processing are particularly important for understanding interpreting, which involves a great deal of deliberate control. The interpreter must keep multiple goals in an active state, with dominance of the goal-based self alternating between them. The highest level goal is of the task of interpreting as such, which includes and supports subgoals of understanding in one language, maintaining the message representation in some detail for a period of time, and producing an utterance in the other language that expresses that message. How the simultaneous activation is maintained, how the shifts in dominance occur, how the processing is shaped by the other factors of internal context, and how these abilities develop, all constitute important research issues. Our hope is that casting them in these terms can contribute to such research. We will return to this topic in Chapter 11, in the context of consciousness as it is understood within the MCF.

6. The affective self as controller

We have so far made only passing mention of the third type of self, the affective self. In Chapter 4 we analyzed it in essentially the same manner as the goal-based self: Representations that are activated together in AfS tend to come together to form a large composite representation, the affective self. As an AfS representation, it is the most highly active of the self representations, evidenced by the central place of affect in conscious experience. So it should be expected to have an especially strong role in control. The limitation on this role is that affective representation and processing does not have anything like the sophistication found in CS and this relative simplicity is inevitably reflected in the character of the AfS self. Its role in sophisticated behavior is necessarily via its influence on the CS goals that guide that behavior.

The role of the affective self, paralleling that of the goal-based self, is to bring a degree of coherence and consistency to the activity of the various emotions and other AfS controllers. Individuals tend to display a substantial degree of consistency in their emotional responses and their moods, showing patterns in their emotional behavior that are at least in principle predictable. A person's emotional behavior can be said to make sense, whether or not this sense corresponds to any independent notion of logic.

The influence of the affective self is expressed through its various connections, namely those already described in regard to its primary components, value and emotion. Representations to which it is connected prominently include those in CS, notably the CS selves and the individual goals that make up the goal-based self. The AfS self is older, both phylogenetically and ontogenetically, and more basic than the higher-level selves and does much to shape them and to influence their activity. It also has direct connections to perceptual modules; patterns in the way we pay attention to and react to our environment are to some extent a product of the AfS self. Finally, affective connections to motor systems allow the affective self to directly influence behavior, an influence seen in very fast, unreflecting responses to provocative stimuli such as familiar objects of fear.

Because the affective self is made up of emotion and value representations, its influence on processing is not clearly distinct from that of emotions or value. It is, again, a focusing and intensification of the influence of one of its components, comparable to the situation with the goal-based self. Like the goal-based self, the affective self can be dominated at a given time by a given component representation, particularly by those of specific emotions, with the result that the impact of the focused representation on current processing and therefore on behavior is greatly enhanced. When the AfS self is dominated by !love! for example, it can provide strong and perhaps overwhelming support to CS goals that express this emotion in one way or another. Phenomenally, this is about the strength of an emotion at the moment: At one extreme, it is just weakly present as a background feeling; at the other extreme it has taken control.

A wide range of intermediate possibilities exists as well, naturally. The affective support received by a given CS goal at a given point will reflect this range of possibilities. A goal that is supported by an emotion that fully dominates the AfS self is almost certain to dominate CS, at least for as long as the AfS dominance continues. In more ordinary circumstances, the goal that is currently dominant in CS might face competition from another goal activated by an active affective representation. A conflict could occur, for example, between a decision to be diplomatic and a desire to express anger. Such a conflict is not simply CS vs. AfS, though, as all goals are by nature valued and therefore receive some support from AfS. The goal of being diplomatic is meaningful and influential to the extent that it is connected to positive value in AfS.

Above, we considered the example of anxiety associated with use of a language, reflecting connections of anxiety in AfS to representations of the language and/or its use. If the anxiety representation comes to dominate the affective self, in more than a fleeting manner, then the full (and considerable) force of the self representation can support CS goals of avoiding use of the language or of avoiding situations in which its use is expected.

The seriousness of the problem depends first on the RLAs of the connections; high levels of course lead to stronger activation of anxiety when the language representations are active. The other crucial factor is how generally the affective representation is connected to language representations. It might be associated only, or primarily, with use of the language in particular situations, such as formal speaking. This is to say that the AfS representation is coindexed with representations not of the language itself or of its use in general but rather with composite representations made up of language representations plus the particular context, formal speaking in this case. If, on the other hand, the coindexation is not so restricted, the result is a much more general sort of language anxiety. Such broad connections and high RLAs associated with them can encourage dominance of the affective self by the anxiety representation, perhaps chronically. To the extent that this does occur, we can say that the person suffers from general language anxiety, or is an anxious person, at least when it comes to using the L2.

7. 'Self' as controller?

Intuitively, self is a single, unified entity, but research on the subject has generally split it into various components, because it is difficult to make sense of the concept without such fractionation. In our framework, in particular, there are three types of self representations, two in CS and one in AfS. The obvious question raised by any such analysis is to what extent we can speak in general terms of a self influencing processing and to what extent we must instead consider the influences of each self as a distinct controller. We briefly considered the question of integration between the goal-based self and the meta-self above and will focus here on goal-based and affective selves.

7.1 'Self' as cognitive controller?

The issue arises when a rational, conceptual judgment suggests one action and emotion suggests another. This is ultimately a goal conflict in the conceptual system, with one goal receiving substantial activation from affective connections. To the extent that the situation is perceived as 'me' battling my emotion, the natural conclusion is that the emotion is not dominating the affective self while the goal of resisting the emotion does dominate the goal-based self, presumably with strong support from elements of AfS – the goal is highly valued. When the emotion dominates AfS and its influence is thus the influence of the affective self, the experience is likely to change from me battling my emotion to me acting on the emotion: The goal associated with the emotion becomes my intention. This suggests that the AfS self is dominating the goal-based self and that the latter falls in line. This is no doubt often the case, and it makes sense given the inherently superior activation levels in AfS.

But there is also reason to believe that a significant degree of functional unity does exist. We previously discussed the schemas involving CS and AfS selves and the possibility that 'self' as a whole can be seen as a schema. Strong and extensive interconnections exist among the self representations, and these connections inevitably push them in the direction of harmony, even if their differing internal dynamics can pull in the opposite direction. How these forces play out in bilingual processing is an important issue.

7.2 'Self' as language controller?

In Chapter 4 we suggested that self, as it is intuitively understood, might be best seen as a schema, i.e. as a well-established pattern of activations spanning multiple modules. The question of whether self can be seen as a unified controller is a question of *how* well-established this schema is. Above and in Chapter 6 we tentatively concluded that there is a considerable degree of unity but that this unity is far from perfect, especially in that affective and conceptual selves often conflict. This conclusion should apply to language control.

The relatively unified character of self can be seen in the example of language anxiety considered above. We characterized an anxious person as one for whom the AfS representation of anxiety is connected to language representations generally, without restrictions to particular contexts. While the problem is affective at its heart, the phenomenon of language anxiety is inseparable from the goal-based self as well, as an active anxiety representation inevitably influences and is influenced by goals of minimizing anxiety. The meta-self also participates, as it is shaped by experienced anxiety ("I am a person who is anxious about speaking in the foreign language"), and can then reinforce the activation of anxiety in AfS and of conceptual goals of minimizing it. These interwoven patterns of activation constitute schemas, reflecting well-established processing patterns and therefore behaviors. In this sense we can say that the various selves together act as a controller.

The limits on the unified control can be seen in cases in which emotion dictates one action and reasoned consideration another. An example briefly noted above was the conflict between a desire to be diplomatic and a desire to express anger. What this means, in our terms, is that a goal of being diplomatic is active in CS, possibly to the extent that it currently dominates the module and thus represents the person's current intention, and !anger! is highly active in AfS at the same time. Because of the strong interconnections between CS and AfS, this is a very unstable situation. The CS intention activates representations, directly in CS and indirectly in the linguistic modules, that will carry out the goal of being diplomatic, while the !anger! representation activates CS goals that will lead to a very different sort of linguistic behavior. We thus have a conflict for dominance of CS processing.

Resolution of the conflict can mean victory for the diplomacy goal if it is highly valued and currently dominates the goal-based self and the emotion is not *too* highly active. It can mean victory for the alternative, anger-expressing goal if the emotion supporting it dominates the affective self and it is competing with a goal that is not extremely active. The two selves, goal-based and affective, thus play a decisive role in the resolution, due to their dominant roles in their respective modules. The resolution necessarily involves one of them adjusting to the other. Given what we know about the relative dominance of the rational and the affective (see for example, Haidt, 2012), we should expect the reconciliation to be more on the latter's terms, at least most commonly. In any case, there is a form of unified control here, by a somewhat unified self, but it is a dynamic, interactive form of control by an imperfectly unified self.

8. The L2 self

In Chapter 4 we briefly considered the idea of the L2 self and its status within MCF. In the context of language control the important issue is how it can influence linguistic processing and behavior. Like self in general, its effect is to bring a degree of coherence and stability to processing, in this case specifically to L2-related processing. Our central concern here is with the way that it can act as a controller.

First, some further consideration of the nature of the L2 self is needed. As we described it in Chapter 4 and as it is most commonly portrayed in the literature, the L2 self is primarily about the meta-self. The ideas of ideal self and ought-to self, as components of the meta-self, are particularly important here. But affect is a crucial part of the idea of an L2 self as well and so the affective self is also relevant. In the context of language control the connection with goals and therefore the goal-based self is even more important, and the relation between the goal-based self and the L2 meta-self will be our main concern.

As with the meta-self in general, the control function of the L2 meta-self is indirect, via goals: It can activate existing goals and trigger the establishment of new ones, particularly goals related to acquisition and use of the second language. If a goal of improving L2 reading ability already exists, for instance, activity of the L2 meta-self can activate it. The ideal and ought-to selves are particularly relevant here. If either or both contain representations of good L2 reader, activation of these representations will naturally spread to the goal of improving L2 reading ability, bringing this goal into play in current processing and behavior and at the same time raising its RLA and thereby increasing its potential influence in the future.

Perhaps more importantly, ideal and ought-to selves should routinely trigger the creation of new goals. In fact, given the nature of goals and how they are established, as described in Chapter 4, these components of the L2 meta-self *have to be* a common source of new goals, assuming only that discrepancies exist between them and the actual self (more accurately, the person's perception of self). Adjusting the above example, suppose there does not yet exist a goal of becoming a good L2 reader. The presence of GOOD L2 READER in the ideal self implies that it is a positively valued representation. If it is recognized as not actual, this means that it has been combined with UNREALIZED, yielding the representation shown in Figure 8.5.

As we described goals in Chapter 4, the conceptual processor by nature combines a representation of this sort with *SEEK* to make a goal representation, as shown in Figure 8.6. This is the goal of becoming a good L2 reader.

The L2 ideal self (and ought-to self) thus naturally triggers the creation of goals related to learning the L2. These goals can then spawn more specific goals, such as finding suitable reading materials, spending time reading them, taking a class that focuses on reading, etc. Ideal and ought-to selves are thus a bridge between the meta-self and the goal-based self.

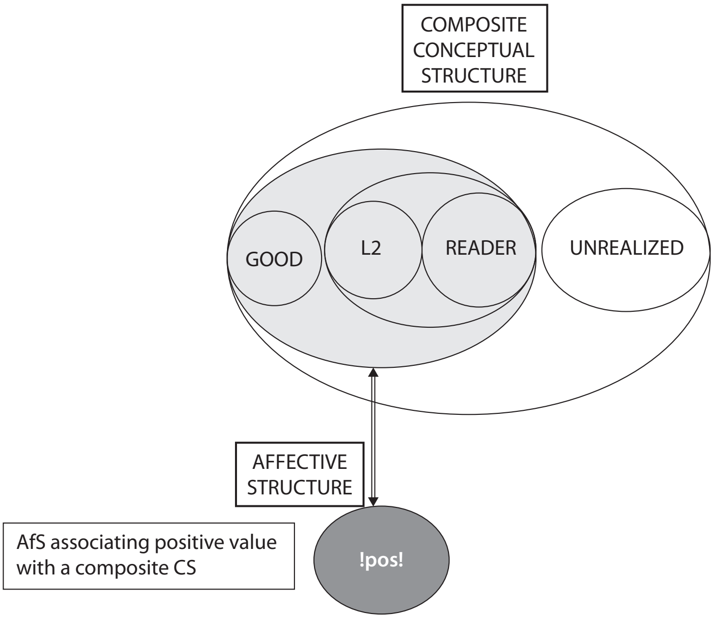

Figure 8.5 The learner values the idea of being a good L2 reader but does not consider him/herself to be one

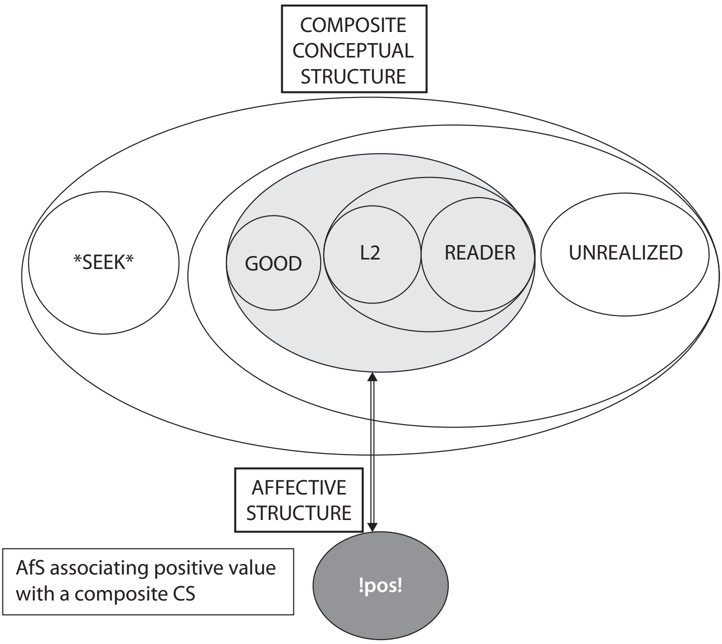

Figure 8.6 *SEEK* is combined with the representation of the perceived lack of L2 reading ability, forming a goal of becoming a good L2 reader

In this way MCF provides a framework for further research on the way that L2 goals develop and influence behavior. As a framework, and an especially ambitious one, it leaves open a great many issues, not only regarding the creation of goals but also the nature of the L2 self. It involves all three types of selves that we have hypothesized, but the details remain unclear. There almost inevitably exist L2-related goals, but to what extent do they comprise an L2 goal-based self distinct from the general goal-based self? Or is it better to think of the L2 goal-based self as an abstraction, picking out from the general goal-based self all those goals that are related to the L2? We know that affect is important for the L2 self, so is there a distinct L2 affective self? To what extent can we speak of a unified L2 self schema encompassing all the self types? To these can be added questions about individual differences among learners. These questions, and others, provide good targets for future research, both theoretical and empirical. We are more interested here in framing the questions than in suggesting answers to them.

9. Conclusion

In this and the two previous chapters we have offered an account of cognitive control as it is understood within the MCF framework and have applied it to language control. Perhaps the central theme is that a theory of (language) control should not be a theory of (language) control. No special mechanisms or principles should be proposed to account for control phenomena; the explanation should instead be a spelling out of the implications of general representation and processing for the particular domain, bilingual language processing in this case. What this amounts to is that cognitive control in general is nothing more than the internal context of processing and language control is nothing more than the internal context of bilingual language processing. Internal context is simply active representations outside the linguistic modules that influence linguistic processing without being a direct part of it. A necessary qualification is that if we are not to deviate too far from common, intuitive notions of control, it is specifically the inherently internal context that constitutes control; outside-in context sets the stage for control.

In this chapter we were concerned in particular with relatively deliberate, volitional forms of control. Control in general involves a variety of factors, and research has made it clear that a person's belief that he/she has made a deliberate choice can often be an illusion (Bargh, 2017; Gazzaniga, 2011; Haidt, 2012; Hood, 2012; Wegner, 2002). At the same time, though, there is a place for voluntary control, or more accurately voluntary *influence*, understood in the way we characterized it in Chapter 4. Several self representations exist, as semi-stable and semi-coherent combinations of many simpler representations, and their activity is loosely coordinated. For cognition in general, thought and behavior are voluntary if they are consistent with activity in the currently dominant goal-based self representation. The same applies to the case of language production: An utterance is made voluntarily if the act of producing it is consistent with activity in the currently dominant goal-based self.

Perhaps the best indication of deliberate control is a sense of effort accompanying the use of the chosen language, as it indicates that the self influence is contrary to other influences. We will return to this point in Chapter 10. Deliberate control without this sense of effort is possible, in a weak sense of 'deliberate', namely that the action is consistent with self, even if other factors were mainly responsible for its occurrence. These forms of deliberate control, even at their clearest, are not however an alternative to the idea of heterarchical control, as activation of the self representation and particular goals within it is itself the product of various factors, including outside-in context.

Inseparable from these considerations is the homunculus issue. The view we are proposing of language control is ultimately heterarchical. There is no one and no thing that accesses, selects, or controls. Instead, there is a great variety of representations within several modules, each directly or indirectly influencing the activation levels of linguistic representations and thereby shaping language performance. Again, this is not to say that there is no such thing as deliberate control, but rather that volition is to be explained in the same heterarchical terms.

This in turn brings out what is perhaps the most important contrast between the MCF approach and existing theories of control. The latter do not explicitly address the role of self but do seem to include something like it, implicitly. In other words, in familiar discussions there tends to be an unstated agent involved in control. Control is carried out by the speaker, the person, attention…or else "control" itself is the implicit agent. This is, again, the homunculus problem. The MCF approach deals with this problem by placing control in the context of a general account of the cognitive system in which it occurs and so seeking to explain it as a consequence of the nature of the system rather than as a thing in itself. This in turn allows an understanding of the distinction between control that seems voluntary and control that does not.

CHAPTER 9

Coactivation phenomena

1. Introduction

Much of the work in bilingual processing centers around coactivation of representations from different languages. An early concern was *whether* it occurs during processing, but research has now left little doubt that it does in fact occur (see Chapter 7), so the concern with whether has given way to a focus on how, i.e. under what conditions it occurs. Work in this area has yielded a great deal of information on this question, though much remains to be done. It is worth noting that we are working at the *cognitive* level of explanation here; phenomena at the neural level should parallel those we consider, but this is another (large) issue.

In this chapter we look at a variety of research findings related to coactivation and show how they are to be explained and studied in terms of internal context as understood within the MCF. We begin with the issue of 'non-selective access', translated into the terms of MCF and internal context, the concern being with the factors influencing the phenomena. Next is the question of the direction in which crosslinguistic influences occur: The weaker of the bilingual's languages tends to be influenced by the stronger, but sometimes the influence is in the other direction and sometimes it is not found at all. This discussion will lead to a consideration of some issues in the way that coactivation phenomena are studied. We then turn to two important phenomena that can be productively seen as coactivation phenomena: optionality in SLA and code-switching. But first we will briefly review, as background, the general MCF approach to coactivation.

2. Coactivation in MCF

Coactivation of representations from the different languages of a bilingual is a product of both strictly linguistic factors and internal context, including inherently internal and outside-in context. Regarding linguistic factors, activation of a PS or SS representation from one language can spread within a store to representations from the other language. This is simply linguistic processing. Turning to context, inherently internal context yields coactivation when an active representation of a goal, self, value, or emotion is connected, directly or indirectly, to SS or PS representations from both languages. CS, which we described in previous chapters as the crossroads of linguistic processing and its internal context, is the main concern here. The identity of the interlocutor is an important example. The representation in CS of a known person is likely to include information about the language(s) spoken by that person, so when this person is the interlocutor the language-related information is active as part of the internal context and so can give a general boost to representations in the specific language(s).

3. Internal context and the variables influencing 'non-selective access'

In Chapter 6, we described in general terms the coactivation commonly characterized as 'non-selective access' and noted that research has identified a number of variables influencing it. In this section we will show how these variables are to be explained in terms of internal context, taking MCF architecture, processing, and representation as background. We will then consider the contrast that has been suggested between two different notions of 'non-selective access'.

3.1 The role of proficiency

One factor that appears repeatedly in the findings is proficiency (for summaries, see de Groot & Starreveld, 2015; Grosjean & Li, 2013; Jiang, 2015; also Bultena, Dijkstra, & van Hell, 2015). Signs of coactivation are much less likely to appear in the performance of relatively balanced bilinguals and of speakers with a high level of proficiency in the second language. A large imbalance in proficiency encourages crosslinguistic effects, with characteristics of the more proficient language typically showing up in processing involving the less proficient. It is important to note, though, that these are tendencies: The effects can go in both directions and balanced bilinguals are by no means exempt from crosslinguistic influences. We will take up these points below.

Proficiency is an external judgment reflecting a variety of factors in the underlying system including, in our terms, both the state of the linguistic modules and the associations between purely linguistic representations and the elements of internal context. Within PS and SS, the system must contain appropriate representations with high enough resting levels that they can successfully compete with alternatives from the other language. If their levels are not sufficient, overt performance is likely to show characteristics of the other language. Such an imbalance means that the influence is typically from stronger to weaker language. When the gap between languages in activation levels is reduced or eliminated – an important part of being proficient in both languages – the effect declines or disappears.

But of course proficiency in a language is not simply a matter of having well-developed linguistic knowledge. It also requires rich, strong, and appropriate connections to nonlinguistic representations, i.e. to the elements of internal context. Language use is goal-oriented; linguistic representations must be connected to the goals for which they are useful and these connections must have sufficiently high resting levels to make their use largely automatic. The activity of goals is necessarily shaped by and given meaning by outside-in context. Their activity is given coherence by self representations and the connections of those representations to linguistic items. Value and affect of course interact with goals and self. They also selectively raise the activation levels of CS representations and therefore, indirectly, those of linguistic representations as well, exerting a strong influence on performance.

3.2 The role of sentential context

A second factor in the presence of observable coactivation effects is the presence or absence of a clear sentential context in the experimental task (de Groot & Starreveld, 2015; Grosjean & Li, 2013; Jiang, 2015; Kroll, Dussias, Bice, & Perrotti, 2015), the presence of which reduces or eliminates the observable effects. When a word from the unused language would not fit the context, especially in terms of semantics, it is not likely to show observable activation.

From an MCF perspective, the sentential context activates existing frames (i.e. composite representations) in PS, SS, and CS that include the target word and therefore further activate it (see Chapter 6, Section 4.2.1; also 7.8 of this chapter). Inappropriateness of the word from the unused language in this sentence context means its current activation level does not get this boost. The result is what might be called monolingual mode (Grosjean, 2001). Even when the word from the unused language is more or less compatible with the sentential context, we should expect these factors to be relevant, if to a lesser degree. The frames that provide the additional stimulation belong to the target language and so will have a relatively direct influence on activation of words in that language and only a more indirect and therefore weaker effect on those of the other language.

A possible parallel with this account can be found in prediction-based processing, in the form of the P-chain framework of Dell and Chang (2014). In this framework, the comprehension process includes a constant string of predictions by the production system about what is coming up next in the input. These predictions are used for processing and, when a failure of prediction occurs, for acquisition. The MCF frames described here might be seen as a source of predictions, as they represent patterns that have occurred in the past and are activated during comprehension, reflecting the portions of the input that have already been processed and providing information on what could follow from those items. Also, if a pattern (frame) has occurred many times it will have an especially high activation level, making it especially likely to appear in processing (provide predictions). These are the frames that make the most useful predictions about what is coming next. Major contrasts between the approaches include our modular architecture and its UG basis, as well as the fact that we do not hypothesize distinct production systems and comprehension systems (we will not go into issues of learning here).

3.3 Additional factors

Evidence also exists that preparation time and repetition of the target words can reduce the role of the non-target language (de Groot & Starreveld, 2015; Grosjean & Li, 2013). Both of these factors are about increased activation of representations of the target language words. Repetition of the intended words means repeated activation of them, which raises their current activation levels. Preparation time can raise the current levels in the same way, because the time is naturally used to rehearse them. So in each case we should expect higher activation levels of the words in the target language and therefore less possibility of interference from the other language.

Grosjean and Li (2013) also noted a number of other factors in non-selective access, related to the experimental task and its conditions, all of which can enhance the role of the unused language. These include the context of the study, the other people who are present at the time, the topic of the task, the stimuli that are used, and of course the experimental task itself. While they did not develop these points in any detail, all of these factors appear to be readily incorporated in the approach described here, as each can be seen as contributing to outside-in context, which in turn helps to determine which language is used. Their influence is directly on the activation level of contextual representations in CS, including goal representations, and so indirectly on SS and PS representations. When the activated CS representations are associated primarily with the unused language, this influence contributes to coactivation phenomena.

3.4 Strong and weak versions of 'non-selective access'

Jiang (2015) distinguished two versions of non-selective access. In the weak version, speakers cannot ignore current input in the other language even when doing a monolingual task. The strong version maintains that the other language affects processing even when everything about the task and the situation is monolingual. From the MCF perspective this is a pre-theoretical characterization of the issues; within the framework, things do not divide in this way.

In this perspective, the weak version refers to one (very important) contextual factor in coactivation and hypothesizes that it inevitably has some influence. In our framework, this is likely to be true; the only issue is whether we can imagine some sort of special circumstances in which the influence would be cancelled – not out of the question, but it is not clear just what such circumstances would be.

The strong version is about what happens when all circumstances favor the use of just the one language. In regard to the person's internal contextual representations it is highly unlikely in practice that everything would be purely monolingual for the person, that nothing in the task or situation would ever have been associated in any way with the other language. There is also the possibility of lingering activation of those representations from recent experiences. Even in the absence of any such support for the other language we should expect to find minimal coactivation but not a complete absence, as activation can spread purely within the linguistic modules. Overall, then, we predict that coactivation will always be present in the strong case but it should be relatively limited and so the unwanted language should have only a limited role in processing.

4. Direction of influence

Coactivation research is about the activity of one language showing an influence on activity of the other. The observed influence has typically gone from the stronger to the weaker, though not always. In this section we will consider how such findings are to be accounted for in terms of internal context as understood within the MCF. We will first look at the general situation and then focus on two particularly interesting cases: asymmetric switch costs and third language (L3) acquisition.

4.1 Internal context and direction of influence

As described above, our account of coactivation and bilingual processing implies that representations from either language can influence processing in the other. It also implies, correctly, that L1-L2 influences should typically be stronger than L2-L1 influences. This is both because L1 representations are likely to have higher resting levels and because their connections to contextual representations in CS are likely to be more extensive and stronger, in the sense of having higher resting activation levels. These better connections imply a greater influence of internal context on processing. Specifically, activity in the contextual representations spreads to the linguistic representations with which they are coindexed; if the L1 has more and stronger contextual connections than the L2, its SS representations will tend to get a boost in their activation levels beyond that received by L2 SS representations. This contextual boost makes L1 processing less vulnerable to L2 influences. The typically more limited contextual boost that L2 representations receive makes them more vulnerable to cross-language influences.

L2 proficiency is an important factor here. Increased proficiency includes, for one thing, higher resting activation levels, making the representations more readily available and better able to win the competition against their L1 rivals. It also means stronger and more extensive contextual connections for L2 representations. The implication is that the asymmetry in cross-language influences should be reduced and that no such asymmetry should be found in fully balanced bilinguals. These are the typical findings in the research. Crosslinguistic influence is found primarily in unbalanced bilinguals, operating especially from the stronger to the weaker language (for reviews, see de Groot & Starreveld, 2015; Grosjean & Li, 2013; Jiang, 2015). This point is well established and accepted.

It has also become clear, though, that influences operate in the other direction as well. Athanasopoulos (2015) summarized research showing changes in L1 conceptual structure as a result of L2 structure. de Leeuw (2014) showed that L1 phonology is affected by L2 phonology, even when the latter is acquired in adulthood. Dussias, Dietrich, and Villegas (2015) summarized evidence for influences of the L2 on L1 syntactic processing. Li (2013) provided evidence that L1 lexical usage is influenced by the L2. These findings are expected, given the account of processing presented in the preceding chapters. Any active representation can influence processing through spreading activation, even if it does not actually enter into the overall representation currently under construction (is not selected, in more familiar but also more misleading terms). If representations associated with one language have relatively low resting levels, their influence will be relatively weak and often undetectable, but the possibility of observable effects always exists. Whether they do occur in any given case is a matter of internal context. Specifically, it occurs when internal context favors representations from the weaker language, boosting their activation levels above those of their competitors from the stronger language. This effect could come from any or all of the elements of inherently internal or outside-in context.

4.2 L3 acquisition

The issue of direction of influence becomes especially interesting in the study of third language acquisition, where by ‘third’ we mean anything beyond two. The topic has seen a recent surge of interest (see, for example, Cabrelli Armaro, Flynn, & Rothman, 2012; García Mayo & González Alonso, 2015). The issue that concerns us here is the following: If crosslinguistic influence can be established in the developing L3, will it be primarily from the assumed dominant language, normally the L1, or from the language that shares most structural characteristics with the L3, or perhaps from any language that shares with the L3 the state of being 'foreign', i.e. not the L1?

Discussion in the previous section and elsewhere provides reasons to expect the L1, assuming it to be the dominant language, to have the strongest influence on the L3. The resting activation levels of L1 representations are typically higher than those of representations from other languages, giving them a substantial advantage in the competition for inclusion in processing and therefore, by APT, in development. So this factor clearly favors the dominant language.

On the other hand, the native language is discounted by some as a possible model for any new linguistic system, making an L3 more likely to be influenced by an L2 (see for example Hammarberg, 2001; Williams & Hammarberg, 1998). In other words, in this view, a new 'non-L1' will be influenced only by other non-L1s in the mind of the individual. Within the MCF, this could mean that the assumed dominance of the L1, by virtue of its high resting levels, is no longer relevant because of the L3's association with a conceptual structure that is not shared with the L1, namely ALIEN (see Truscott, 2015a). This idea captures the intuition that languages other than the first share an 'otherness' which puts them in a separate category from the native language. One could also say, if the existence of inhibitory processes are to be included in the MCF, that the activation levels of non-alien schemas will be depressed in favor of all alien ones. While this type-casting of languages is always possible, it is questionable whether a CS like ALIEN would have such a dramatic global effect, at least on processing activity in the linguistic modules.

The idea that structural similarity is the key factor in crosslinguistic influence on the L3 can be seen in the discussion by Rothman, Iverson, and Judy (2011) in a special issue of *Second Language Research* devoted to the generative study of L3 acquisition. The authors define the various approaches taken to defining the 'initial state' of the grammar for L3 acquirers: They focus their attention on two approaches that share the notion that the resources of all previously acquired grammars (defined in generative linguistic terms) are available in principle for creating the new L3 grammar. The two approaches are described by Rothman, Iverson, and Judy as differing in the way they deal with the potential inhibition and facilitation of the acquisition of the L3. The Cumulative Enhancement Model (Flynn, Foley, & Vinnitskaya, 2004) allows only facilitative transfer from all previously acquired grammars whereas the Typological Proximity Model (Rothman, 2011, 2015) predicts both facilitative *and* inhibitory effects.

The hypothesis that structural similarity determines the relative influence of other languages on the L3 is expressible in MCF terms as follows. Languages that are typologically similar will naturally have more in common, particularly in SS, than those that are not. These shared features (representations) will result in a higher degree of coactivation and therefore a higher degree of influence on each other. There is, then, reason to expect typological similarity to be an important factor in determining which language has the stronger influence on the L3. That this is not the ultimate determining factor follows from the fact that structural similarities between languages in the L1/L2/L3 do not have to follow a consistently typological pattern even within a particular linguistic domain like syntax, so it is really *structural* rather than typological similarity that is the most important factor. For instance, there may exist structures in a typologically unrelated L1 that nonetheless are shared with L3 and these will accordingly influence L3 development and performance. This structural similarity principle would therefore position MCF more in line with the Linguistic Proximity Model (see, for example, Westergaard, Mitrofanova, Mykhaylyk, & Rodina, 2017). The MCF is neutral on the issue of inhibition, taking its absence as the default option but remaining open to the alternative view.

In Chapter 11 we will explore another approach to these issues, involving metalinguistic knowledge as it is understood within the MCF. At this point we want to return to the general point that a broad framework is valuable, if not essential, for studying such issues. As with code-switching and other subtopics within bilingualism discussed in this book, 'local' theories and hypotheses devised to explain experimental findings that relate to very specific aspects of language have been advanced to solve issues without the background support and plausibility checks offered by a(n apparently unavailable) general theory of cognitive processing that is sufficiently well-defined to allow more general principles concerning representation and online processing to be usefully brought into the local explanations of specific types of phenomena.

In other words, language dominance versus structural relatedness questions and how crosslinguistic influence might affect the growth of new languages are not just L3 acquisition issues but also pose the kinds of question that a broad theoretical perspective such as the current framework is supposed to help provide answers to. The particular conditions pertaining in the case of various kinds of L3 acquisition need to be explicitly related to these general principles. In other words, there is a role both (a) for the research carried out by local investigators focused on the specific circumstances of L3 acquisition and (b) for the application of an overarching theoretical framework which may favor or render less plausible any local explanations of the phenomena in question.

5. Coactivation phenomena and experimental paradigms

A number of experimental paradigms are now the standard sources of data in this research area. An important question then is how these paradigms are to be understood in terms of the MCF and internal context. What exactly is going on in the experiments? To offer initial answers to this question we will consider one popular paradigm, picture naming, focusing on the way it translates into the MCF framework and the notion of internal context.

5.1 The picture naming task

In picture naming tasks, participants are shown a picture, of a tree for example, and asked to name it in one of their languages. The dependent variable is typically the time needed to respond. The independent variable is the relatedness of the names in the two different languages – the language that is being used and the one that is not. The two words can be cognates, for instance, or they can be selected to resemble or fail to resemble one another in various respects. If reaction time is affected by these factors, the conclusion is that the word from the unused language is active and so is exerting an influence on processing.

In MCF terms, the picture is an active representation in visual structures. Because the pictures used in the studies are of familiar items for which names are already known, coindexed representations exist in CS (the abstract concept TREE), as well as in SS and PS (the linguistic forms of the words in each language), and AS (the sound of the words as they are consciously experienced). Activation thus spreads from the VS representation to its conceptual counterpart and from there, possibly with diminishing strength, to the SS, PS, and AS representations. From this theoretical perspective it is not a question of whether coactivation occurs but rather the extent of the coactivation, especially whether it is sufficient to show up in the measurements. The research question is how this extent is influenced by the relatedness of the words in the two languages.

5.2 Picture naming and internal context

Consider then the way that the various factors of internal context are influencing the processing in this paradigm. First, a goal has been activated or created by the demands of the task, specifically by the instructions given to name the pictured item in a particular language, say Spanish. Activity of this goal representation raises the activation level of the SPANISH representation in CS, and therefore of all word meanings that include it, i.e. representations that are labeled as belonging to Spanish. The goal-based self is likely to be involved in the processing as well, supporting the goal, to exactly the extent that following the goal can be considered deliberate.

An interesting complication in this scenario is that the instructions might also lead, directly or indirectly, to creation/activation of a goal of *not* answering in the other language, say English. The effect is that whenever an English word becomes highly active, its CS is likely to be combined with this veto representation: "don't say this word". But a goal of not using English naturally includes the concept ENGLISH and so this goal will raise the activation levels of English representations. How this activity interacts with that of the positive goal is not obvious, but there is little doubt that an additional variable is present here.

Outside-in context in the picture naming paradigm has a number of components. The most important is presumably the picture, as represented in VS. Also significant is the setting, including assorted features of the physical location, interpreted in terms of relevant representations that the person already has, and of course the experimenter and any other people present. Again, representations of these things in CS become internal context for performance of the task. Their importance lies in the fact that the meanings of the words in the different languages are not just the core meaning, TREE for example, but rather this meaning plus the contextual representations that have become associated with it for each language. The language used by the experimenter also has a more direct influence, because active PS and SS representations of what is said activate other representations of that language, encouraging their use in the task.

The remaining elements of internal context, value and emotion, also have a role to play in the picture naming paradigm. The active visual representation of the picture and the associated concept activate any affective representations associated with them; in other words familiar items and the words that refer to them come with positive or negative attitudes and sometimes specific emotions. These factors can enhance their activation levels, the degree of this enhancement reflecting the resting levels of the indexes that constitute the connection. Consider, for example, a picture of a deadly snake vs. a picture of a laughing baby vs. a picture of a chair. In the typical case the first two have strong affective associations, one negative and the other positive, and so should substantially contribute to the activation levels of the picture and the concept, while the third involves more limited affect, which therefore has a more limited influence.

These variable influences could affect the results of experiments. If, for instance, a Spanish word with a very similar English cognate has significantly stronger or weaker affective connections than another Spanish word that has no such cognate, the affective factor could either produce a spurious contrast in reaction times or obscure a genuine contrast. Thus, the affective value of the words must be controlled. A limitation on efforts to control this factor is that individuals can vary in the affective associations they have for different words. In second language learning, for example, a learner might well have a salient positive experience with a particular L2 word and a salient negative experience with another.

5.3 A note on ecological validity

The research we have described in this and the previous chapter abstracts away from fundamental aspects of bilingual processing as it occurs in normal life. The designs of the switch cost studies effectively remove most of the internal context that is constantly and crucially present in more realistic bilingual processing. Perhaps most importantly, they remove the speaker's normal goals, replacing them with the experimenter's goals. One has to ask then to what extent the findings are a genuine phenomenon rather than an artifact of the experimental procedures. In other words, how much can they tell us about bilingual processing as it occurs outside the lab?

There is an element of faith in this work, an implicit assumption that in doing research we can abstract away from these fundamental features of language use and then treat the findings as direct evidence on the nature of bilingual processing and behavior. This is not to say that the approach is necessarily misguided. The findings presumably do reflect, however indirectly, the nature and workings of the system; if we are to fully understand this system, we need to understand why it behaves the way it does when normal features of bilingual processing are removed. The question is how such findings are to be used; what kinds of inferences can and cannot be legitimately drawn from them? This issue of ecological validity deserves considerably more attention than it commonly receives.

This is not to say that it has been entirely ignored in the study of bilingual processing. We described some exceptions in Chapter 8. One striking example is the work of Blanco-Elorrieta and Pylkkänen (2017) using magnetoencephalography to study code-switching both in the lab and "in the wild", i.e. in natural conversation. The dramatic contrasts they found between the two conditions should set off some alarm bells, particularly regarding the importance, or lack of importance, of executive control in naturalistic switching. Strong contrasts have also been found in psycholinguistic studies that compared cued and voluntary switching (de Bruin, Samuel, & Duñabeitia, 2018; Gollan & Ferreira, 2009). Findings of this sort deserve a prominent place in discussions of bilingual processing.

5.4 Conclusion

Setting aside the issue of ecological validity, the discussion in this section points to a large number of variables to be considered and explored. We are not suggesting that all these factors must be taken into account in each experiment. Scientific research necessarily abstracts away from many variables. But there should be a recognition of what it is that is being factored out in the experimental design, along with serious consideration of what the implications might be. The point we want to emphasize, though, is that subjects' performance in the experiments is a function of the internal context in which it occurs, which itself is a product of the architecture, representation, and processing of the system, and it can only be adequately understood in these terms.

6. Optionality in SLA

In the field of second language acquisition there is a substantial literature on optionality: learners' varying use of two different forms, each of which should be expected to exclude the use of the other (e.g. Foster-Cohen, Sharwood Smith, Sorace, & Ota, 2004; Parodi & Tsimpli, 2005; Robertson & Sorace, 1999; Sorace, 2000; Truscott, 2006; White 2003). In the typical case one is the correct L2 form while the other reflects the characteristics of the L1. This is, in other words, an example of active representations from the dominant language influencing processing in the weaker language. In this section we will first describe the general phenomenon and summarize the explanation we have offered for it (Sharwood Smith & Truscott, 2014b; Truscott, 2006). We then extend this explanation to include the role of internal context.

6.1 Optionality and why it occurs

The observation that brought optionality to the attention of generative researchers was originally made by White (1991, 1992a, 1992b), involving the kinds of sentences shown below (Truscott, 2006, p. 313).

> * Alice ate not the mushroom.
> * Alice ate quickly the mushroom.

White's observation was that French-speaking learners of English accepted and produced these types of English sentences (presumably because the structures are grammatical in French) alongside their grammatical counterparts, apparently treating them as interchangeable.

Subsequent research both confirmed the original observation (Eubank, 1994, 1996; Eubank & Grace, 1998; Vainikka & Young-Scholten, 1994, 1996a, 1996b, 1998) and identified a variety of additional cases (Foster-Cohen, Sharwood Smith, Sorace, & Ota, 2004; Hilles, 1986; Lakshmanan, 1994; Müller, 1998; Prévost &

White, 2000; Robertson, 2000; Robertson & Sorace, 1999; Vainikka & Young-Scholten, 1994; Westergaard, 2003). It would be little if any exaggeration to say that optionality is the norm in second language acquisition.

An essential characteristic of the phenomenon, found in all these cases, is a gradual shift in the frequencies with which the two options are used. Initially, the L1 representation is used extensively, at the expense of the appropriate L2 representation, but this interference gradually declines in frequency as L2 proficiency increases. The parallel with findings described above regarding (non-)selective access should be clear: The degree to which access is found to be non-selective depends on the relative dominance of one of the languages, and it declines with increasing proficiency. Each is a case of one language initially exerting a strong, asymmetric influence on the other and the influence gradually declining with increased proficiency.

The discussion above points to a natural explanation for these findings. There are two SS representations, one associated with each language, coactivated and competing for inclusion in processing. When the L1 representation has a much higher resting level, as is expected when the L2 is relatively weak, it has a substantial advantage in the competition and will therefore interfere in L2 processing. As the resting level of the L2 representation rises through processing experience, this advantage gradually declines, so we see a gradual shift in the probabilities of each item appearing.

6.2 Optionality and internal context

To this point we have analyzed the phenomena in probabilistic terms, without trying to say why, in a particular case, one item appears rather than the other. But in principle, and hopefully in practice, explanations can go beyond this limitation, using the notion of internal context: It is internal context that determines when the appropriate L2 representation will triumph. The relative current activation levels of the competing representations are the immediate determinant of which appears in performance in a given case. Current activation level is in turn a function of internal context (along with the purely linguistic factors, of course). For low proficiency speakers, a particularly strong contextual influence is needed to raise the activation levels of the L2 representations to a point where they can successfully compete with their L1 rivals. As proficiency rises, the increasingly high resting activation levels of the L2 linguistic representations obviate the need for such strong contextual support.

At the same time, increased proficiency also means the development of strong connections between specific L2 forms in SS and PS, on the one hand, and representations of internal context on the other. We are assuming here that contexts strongly associated with L2 use typically differ from those strongly associated with L1 use (recall the Complementarity Principle). Development of contextual connections for the appropriate L2 linguistic representations thus results in contextual support for the use of those representations. As the resting levels of these connections (i.e. the indexes) gradually rise through processing experience, the contextual support becomes stronger and relatively automatic.

This development depends on the learner encountering (and accurately processing) sufficient input that includes correct uses of the form, i.e. sentences like "Alice quickly ate the mushroom". Each such instance will occur in a context and CS representations of that context will therefore become associated with the form. Further instances then contribute to gradual increases in the resting level of the index. The absence of such processing experience for the *incorrect* form will limit the possibilities for development of (unwanted) connections between it and contextual representations. Thus, the desired form will gradually come to receive contextual support while the unwanted form will not.

There are no guarantees of successful development along these lines, though, for several reasons. First, the input might be insufficient or might be wrongly processed. Second, depending on the nature of the learning environment, the learner might encounter instances of the ungrammatical form, e.g. "*Alice ate quickly the mushroom", resulting in its coindexation with the current context or, if this has occurred before, raising the resting level of the index. Finally, if the learner uses the incorrect form in production this in itself can establish and strengthen the unwanted contextual connections, both directly, through the processing that constitutes production, and indirectly, by immediate comprehension of the utterance, what has been called *auto-input*, *virtual input* or *back-door learning* (see Schmidt & Frota, 1986; Sharwood Smith, 1981, 1996; Terrell, 1991).

The observed shift away from optionality and toward more native-like performance can thus be attributed to two interacting factors: the purely linguistic factor of rising resting levels of L2 representations in SS and PS and better connections between those representations and the elements of internal context.

7. Code-switching

The topic of code-switching was briefly discussed above on a number of occasions. A more extensive discussion may be found in Truscott and Sharwood Smith (2017) and also, with special reference to the role of affective processing, in Sharwood Smith (2017c). The concern as always is to find the best way of representing psychologically, i.e. within the framework, the role of what is usually a complex set of factors that determine when interacting bilinguals or multilinguals switch from one language to another. Put another way, it is to establish what representational networks, that is to say, what schemas are involved. As was stated at the outset of Truscott and Sharwood Smith (2017), a theory of code-switching should not be a theory of code-switching but rather a spelling out of the implications of a more general theory as applied to the phenomena of code-switching. This principle can be more generally applied to most if not all of the phenomena considered in this book.

In this section we will explore the possibilities for explaining code-switching in terms of internal context as it is understood within MCF. After some background discussion and review and further development of language identification in MCF, we consider how each of the elements of internal context – outside-in, goals, value, emotion, and self – influence switching. We then turn to the role of linguistic factors, i.e. to the state of SS.

7.1 Some background on code-switching

Code-switching may be approached from different points of view adopting a social, anthropological, psychological, or neurological theoretical perspective. For example, there has been much discussion in the literature concerning the mixing and the inhibition of languages during bilingual language use including the linguistic principles that might determine switch points (Auer, 1984, 1995; Blom & Gumperz, 1972; Heller, 1988; MacSwan, 1999, 2000; Myers-Scotton, 1993; Poplack, 1980; Sankoff & Poplack, 1981). The motivation behind code-switching has also been studied using sociolinguistic and conversational analytic perspectives (Auer, 1984, 1995; Wei, 1998) while others have employed a neurolinguistic perspective to explain how bilinguals control their different language systems (e.g. Costa, Santesteban, & Ivanova, 2006; Green, 1998; Green & Wei, 2014; Jylkkä, Lehtonen, Lindholm, Kuusakoski, & Laine, 2017).

Interdisciplinary approaches have been adopted to examine the interaction of sociolinguistic and psycholinguistic factors (Kroll, van Hell, Tokowicz, & Green, 2011; MacSwan, 1999; Myers-Scotton, 1993; Pfaff, 1979; Poplack, 1980). Some researchers have looked at switching and mixing in simultaneous interpreting (e.g. Christoffels & De Groot, 2004) and in sign language users who are able to code-switch between sign languages but also, in some cases, to 'code-blend', i.e. simultaneously use a sign in one system and a spoken word in another (for example Dias, Villameriel, Giezen, Costello, & Carreiras, 2017; Emmorey, Petrich, & Gollan, 2012; Schaeffner, Fibla, & Philipp, 2016).

A number of overviews of code-switching research are available which include selections from particular specialized research domains (Abutalebi & Green, 2008; Bialystok & Craik, 2010; Bullock & Toribio, 2009; Costa, Santesteban, & Ivanova, 2006; Dijkstra & van Heuven, 2002; Gardner-Chloros, 2009; Milroy & Muysken, 1995). However, theoretical explanations that attempt to synthesize research findings across a range of specialized domains are hard to find (cf. Goldrick, Putnam, & Schwartz, 2016a, 2016b; Truscott & Sharwood Smith, 2017). One great advantage of the approach adopted in this book, we feel, is that it combines the study of the properties of linguistic and other cognitive representations together with the properties of real-time processing. In this way, code-switching research focusing on one or other of these two fundamental dimensions of bilingual ability can be placed each in relation to the other, and in relation to cognition in general, and hence into an integrated perspective. The study of code-switching then effectively becomes one more way of understanding human cognition in general.

7.2 Language identification revisited

In Chapter 7, and elsewhere, we considered the ways that the bilingual's two languages are functionally separated during processing. This issue is of course central for an understanding of code-switching, so here we will go into somewhat greater detail. The issue is how the multilingual mind identifies, with or without conscious reflection, the different language systems at its disposal, i.e. the schemas that contain phonological and syntactic representations that we, as outsiders, know to be Chinese or Polish, for example.

Having considered one obvious technical solution, namely to hypothesize a system of language tagging whereby any linguistic structure had a marker identifying the language system it 'belonged to', we settled on the more parsimonious solution of 'conceptual triggering' (Sharwood Smith & Truscott, 2014b, pp. 187–189; Sharwood Smith, 2017b, pp. 176–178). This locates the conceptual memory store as the source of representations that represent the identity of a given language, in other words its 'ID'. These representations can then function as language identifiers when directly associated with other non-linguistic representations. In the case of a French painting, for example, the representation FRENCH would be associated with, amongst other things, a visual representation of a painting. Such conceptual representations will of course have multiple associations both within the conceptual store, i.e. with other conceptual representations, and with various other stores, including the perceptual ones. Particular tastes and smells for example will be associated with CS FRENCH. There will be different affective associations as well.

Also, in line with Grosjean's (2010, 2016) Complementarity principle (see Chapter 3), certain topics of conversation, types of situation, registers and uses of language will trigger schemas that have a particular language ID in the bilingual's conceptual memory store as their hub. This, provided there is nothing to inhibit the schema that is centered on this language ID, will make it the currently dominant one. Where another language has been in use up to that point, a codeswitch to the now dominant language will automatically occur. The Complementarity principle also points to a more subtle, implicit form of language identification. CS representations of the topics of conversation, types of situation, etc. that can trigger a particular language ID are also differentially associated with particular words and expressions of the languages and so can act as language selectors even in the absence of the explicit ID (see the discussion involving Figure 8.4).

In the case of code-switching, the language-related associative schemas would obviously include auditory representations of speech (AS) and visual representations of written text and sign language gestures and hand shapes (VS). The association between sound and visual patterns on the one hand and a given language on the other can occur even without any ability to comprehend the language. We are able, without an ability in the relevant language, to learn how to recognize the sound of, say, French or particular orthographic patterns as being Dutch or indeed orthographic characters as at least being Chinese, that is, without actually knowing whether it was Mandarin, Cantonese or other linguistic system included in the label 'Chinese' that uses this particular orthography. In such cases, there need be no linguistic representations in the schemas. Very often the schemas will include CS other than just the one that identifies the given language. Provided their resting levels are high enough for them to figure in conscious awareness, there will be the accompanying metalinguistic knowledge that makes the individual able to explicitly identify which language is involved.

Having separated out in *principle* language identification from any ability in the languages concerned and therefore any ability to switch linguistic codes, in *practice* it is unlikely for there to be literally no linguistic representations active when the 'language-free' schemas are operating in on-line processing. This is because the linguistic systems are geared to always try and make sense of any input that comes their way. Even in the absence of any CS that represents the assumed meaning of some language-related auditory input, some default linguistic representations may be triggered. When processing an unfamiliar or only partially acquired language, 'word-like' input that cannot yet directly be associated with any meaning by using the current linguistic and situational context, might still trigger both a phonological word (PS) structure and a syntactic noun structure (SS) for instance. If any similarity can be established between the input and some L1 structures, for example, these will be coactivated, along with their associated meanings (CS). The activated L1 structures can then potentially function as the current defaults for the unfamiliar word and supply a provisional meaning.[1]

1. The provisional defaults for unfamiliar input can of course come from associations *within* one particular language that the bilingual has at least some knowledge of and so the same idea can

In this section, we have described the ways in which the different languages of the bilingual are in effect separated in CS.[2] With this discussion as background, we now turn to consideration of exactly how and why code-switching does and does not occur. This means looking at the role of each of the various factors of internal context.

7.3 The role of outside-in context in switching

Code-switching is obviously influenced by the circumstances in which it occurs, and this is the natural starting point for discussion of the processes involved. The influence is not from the circumstances themselves but rather from the way in which they are represented in the current state of the cognitive system, i.e. from the internal context. For language production, and therefore for code-switching, this primarily means the currently active representations in CS, constituting a conceptual picture of the external circumstances as perceived by the person. This will typically include, among many other things, the location, the time, the identity of the interlocutor(s) and to a lesser extent any other people who are present, as well as any preceding dialogue.

For bilingual control, perhaps the most important factor of this sort is the interlocutor. Recognition of the person's presence activates any existing representations of that person, which then constitute a prominent part of the internal context. These will include representations of the person's linguistic ability, whether known or inferred or guessed at, along with contexts in which that person tends to be present – associated differentially with the specific linguistic representations and the language ID. These factors will influence not only the language that is used but also the likelihood that a switch away from it will occur.

Consider a Mandarin conversation in Taiwan between two students, and the likelihood of a switch to the Taiwanese language occurring during the conversation. The most basic case is when the interlocutor is known or believed to have no understanding of Taiwanese, in which case, of course, interlocutor identity strongly influences the likelihood of a switch. Interlocutor identity can also play a role when the person is known to understand Taiwanese. While a switch to Taiwanese is likely in a conversation with friends who speak the language, it is

be applied when a monolingual encounters an unfamiliar word. The assignment of its PS and SS will certainly be easier, the more the bilingual is familiar with the phonological and syntactic characteristics of the language. Also, when dealing with written language, the orthographic conventions will usually help by making the word boundaries clear, using blank spaces.

2. The same basic system of identification centered on the conceptual system works for different varieties of a single language, different accents, registers and so forth.

unlikely with teachers, even those who are known to be fluent in the language, because teachers have always interacted with the student in Mandarin. This is to say that the TEACHER concept in CS is strongly associated with one language and not the other. This association can take the form of a composite representation including TEACHER and MANDARIN. It can also reflect the more diffuse connections captured in the Complementarity Principle. The physical setting can also have an influence. The switch is more likely to occur outside of the school context, as Mandarin has always been the school language. These are all examples of outside-in context influencing the likelihood of a switch.

As this example illustrates, outside-in context is always established in the context of existing representations, which is to say LTM. If the interlocutor is known to the speaker, then the internal context is dominated by already-existing representations of the person, now in an active state. If this is the first encounter, it will result in activation of an assortment of existing representations related to (or constituting) the perception of the person. This is to say that we automatically make inferences about the people we encounter, sometimes explicitly and sometimes implicitly.

7.4 The role of goals in switching

Given the importance of goals in cognition and behavior in general, their importance for an understanding of code-switching can almost be taken for granted. From an MCF perspective, an active goal activates related representations in CS, which in effect serve as means of carrying it out. The active goal thus does much to shape the message representation that will serve as the basis for an instance of language production, and thereby to strongly influence activity in SS and PS, making certain representations more likely to be used in production.

Perhaps the most basic, ordinary goal in language production is to accurately express a message. Bhatt and Bolonyai (2011) offer the example of a Hungarian-American inserting the English term 'homeland security' in an utterance that was otherwise entirely in Hungarian. This term has acquired special connotations in current American society, which provided the context for the utterance, and it was unlikely that any Hungarian word would capture those connotations, so the switch served the goal of expressing the message accurately.

Consider what was actually going on in production in this case. The CS representation constituting the concept of homeland security, as understood by the speaker, was active as part of the CS message representation. Because it is coindexed with the SS and PS of the English term 'homeland security', this term will be included in the utterance, barring strong challenge from related Hungarian words, which were also active simply by virtue of their relatedness to the concept that is included in the message representation. The activation level of these words suffers, relative to that of the English term, because their CS components do not include the contextual features that contribute to the latter's activation level. The English term might also have enjoyed a high activation level to start with because of frequent occurrence in the speaker's recent experience, adding to the likelihood of its being included in the utterance.

Of course a great many other goals also guide language production, and therefore code-switching. High level goals include, for instance, face, affiliation, and power. More specific goals include avoiding conflict, sounding friendly, expressing gratitude, showing off, intimidating another person, and countless others. Each can influence the likelihood of a switch.

The influence of goals naturally interacts with that of outside-in context. If the interlocutor is not expected to understand the English term, for example, the CS representation of this contextual factor might lead to a veto on the use of the term and/or contribute to the activation of a rival Hungarian term. The relative resting levels of the English and Hungarian terms are also relevant, as always. Interactions also occur with the other factors of inherently internal context, factors to which we now turn.

7.5 The role of value in switching

Value has two distinct but interrelated roles in production, and therefore in code-switching. First, value representations in AfS are directly connected to CS representations and so can influence their activation levels and thereby the likelihood of their inclusion in a message representation and in the utterance that expresses the message. Second, value is inseparable from goals, as a goal by nature includes a valued state and the activation level of the goal is strongly affected by the strength of this connection to value.

Beginning with the more direct influence of value on production/switching, recall the example above of a Taiwanese student speaking to a teacher or former teacher. The point noted there was that the student is unlikely to switch to the Taiwanese language at any point in this context, even if the teacher is known to be fluent in it, because MANDARIN has become associated with TEACHER through past processing experience and the identity of the interlocutor as a teacher activates this (TEACHER + MANDARIN) representation, and this in turn implies activation of MANDARIN and all other representations that include it. This is an influence of outside-in context. But this is only part of the story, as this influence is tied up with value connections. Specifically, the composite representation (TEACHER + MANDARIN) has positive value, encouraging its continuous use; the (TEACHER + TAIWANESE) representation has negative value, encouraging a veto on its use, including a switch to it. A corollary is that it feels wrong to use Taiwanese when speaking to a teacher (see Truscott, 2015a).

Value is also important in code-switching because of its intimate connection with CS goals. Goals, again, are by nature valued, meaning that they are coindexed with value representations in AfS. These connections allow it to contribute to the activation level of a goal, to varying extents depending on the activation level of the index connecting them. The result of this influence is that the more highly valued a goal is the more likely it is to play a dominant role in CS processing, shaping current activity there in a way that will lead to its achievement. Dominance in CS means dominance of the origins of language production, via connections to SS representations, and so its importance for production and switching is clear.

If the goal of impressing a particular interlocutor or listener is especially important to a person speaking in Mandarin – i.e., the goal is highly valued – then inserting English words or expressions might follow. Depending on the individual and the situation, this goal of impressing others might compete with a goal of expressing ethnic identity or solidarity with the listener, each of which would lead to continued use of the shared L1, i.e. the avoidance of a switch.

7.6 The role of emotion in switching

As described in Chapter 7, the role of emotion as (language) controller is essentially a further specification of the role of value, because value is the primary component of each emotion representation. Returning to the example just considered of a Mandarin speaker switching to English in order to impress listeners, the value of the goal is presumably tied up with the emotion of pride, specifically the speaker's pride in his/her English ability. Consider the following switch (example 7 of Truscott & Sharwood Smith, 2017).

Ni hui you yijong *sense of achievement*.
You will have a *sense of achievement*.

The message here could have been readily expressed entirely in Mandarin. The likely motive for the switch is not accurate expression but rather pride, associated with the goal of demonstrating to listeners the speaker's knowledge of English. At the heart of this goal is the value associated with knowledge of English (as well as listeners' opinion of the speaker). This is to say that the AfS representation !pride! is coindexed with CS representations of English knowledge and the goal of expressing it, and that positive value is a component of !pride!. The English phrase has triumphed over its Mandarin competitor because of this connection. Hence the switch.

7.7 The role of self in switching

As described above, switching is shaped by goals, value, and emotion, i.e. the components of self representations. The effect of a self's involvement is to establish a degree of coherence and consistency in the switching over time and, more to the point here, to focus and strengthen the influence. As in previous chapters, it is useful to speak both of the distinct selves – goal-based, affective, and (of lesser significance here) meta-self – and a unified 'self'. Discussion of the goal-based self's influence, our focus here, is essentially an extension of the discussion of the role of goals, which are of course its components.

For present purposes the most interesting aspect of the goal-based self's role is its deliberate character. As described in Chapter 8, volitional activity is activity in which the goal-based self has a dominant role, promoting the goal that currently dominates it. So when a switch is based on a particular goal and that goal dominates the goal-based self, we have deliberate switching, which for this reason can also be called self-based switching. The extent to which it typifies code-switching is probably very dependent on the individual and the type of context.

An important feature of self-based switching is that it is likely to take more time than more automatic switching, possibly showing overtly in reduced fluency of speech, simply because time is required for a goal to achieve dominance of the self. When no such slowing is apparent, it is likely that the self did not play a causal role, at least not a direct one, even if the switch is fully consistent with the person's intentions. In such cases the switch is likely to have been set in motion automatically, by the influence of other factors of internal context, before the self became involved. This is volition not in a causal sense but rather in the sense of self endorsing what has already happened, or is already happening. This distinction should be reflected, if imperfectly, in the person's conscious experience of making a decision on the one hand or of simply feeling, post hoc, that the switch fit his/her intentions.

This volitional aspect of the goal-based self is difficult to separate from the activity of the affective self. In Chapter 2, we described the self as a schema including the various special selves, a very well-established schema, with strong and extensive interconnections constantly pushing its partners toward synchronized processing. Thus, if the goal-based self is fully recruited by a particular goal, at least if this state persists for any length of time, the affective self is likely to be acting in concert with it, and extremely unlikely to be challenging that dominant goal. In this sense it makes sense to speak not only of the individual self representations but also of the role of 'self' in code-switching.

7.8 The role of purely linguistic factors in switching

To this point our focus has been, as expected, on the way that the various factors of internal context influence switching. But these influences must be seen in conjunction with those operating within the linguistic modules, PS and SS. Researchers have traditionally recognized two major questions regarding code-switching: 'why' and 'where' (Poplack, 1981). The why refers to the social and psychological factors underlying the presence or absence of a switch, which is to say the internal context. The where is about linguistic analysis of the switches. In this section we turn to the where question. Our focus will be on syntactic factors, i.e. on SS. This means both the current state of representations in the syntactic store and the constraints inherently present in the syntax processor.

A key factor is the resting activation levels of the various representations that could in principle be used in a given instance of processing. In the competition for inclusion in processing, resting level serves in effect as the starting line. Representations with high RLAs have a substantial advantage over those with lower RLAs. This advantage is not necessarily decisive, as there are a number of additional factors that can, in principle, raise the current level of the initially weaker representation above its initially more active rival. But the starting point is nonetheless of great importance.

The extreme case is that in which the L2 is quite weak. This weakness can mean that representations associated with the language have very low resting levels, making their triumph over strong L1 rivals unlikely without concerted effort (i.e. strong involvement of the goal-based self; see Chapter 8). In such cases the speaker may revert to more readily-available L1 items. In less extreme cases, an imbalance in RLA should still significantly influence the likelihood of a switch occurring.

The other general factor within SS is the compatibility of the switch with linguistic requirements. A syntactic representation that has a high resting level and is further stimulated by contextual factors might still fail to appear in performance because it is not compatible with the overall representation that is being constructed in SS – its inclusion would result in a representation that violates in-built principles of the processor. This is very much an issue of the nature of the syntax processor; i.e., it is dependent on the particular syntactic theory one adopts. We will adopt here our earlier discussion of the processor (Sharwood Smith & Truscott, 2014b), without going into much detail, while recognizing that a great many other possibilities exist.

Consider the following cases of switching from Mandarin to English (examples 5 and 6 of Truscott & Sharwood Smith, 2017).

*neige guowang *of England*
the king *of England*

neige *England* de guowang
the *England* king (= 'the king of England)

The general principle here is that a complement must fit with the subcategorization frame of its head – regardless of whether noun and complement come from the same language or from two different languages.[3] This requirement is met in the second example but not in the first.

Following the approach we outlined in Sharwood Smith and Truscott (2014b), the phenomena are to be explained in terms of an established SS representation that includes as its components syntactic representations of the head and its potential complements. Such representations are established in processing and then, as their resting levels rise, come to serve increasingly as frames for subsequent processing. Activation of the head results in activation of the entire frame; representations of specific complements can then serve as fillers for the rest of the frame.

In the examples, the large representation includes the SS of the head, 'guowang' (king), and the SS of potential complements. Crucially, this representation specifies the order in which its components appear.[4] Mandarin noun frames include only prenominal complements, as in the acceptable example above. Inclusion of the postnominal phrase 'of England' is thus inconsistent with the highly active frame, resulting in ungrammaticality. In terms of processing, the large representation including 'of England' is entirely novel and therefore has a very low resting level, with the implication that it is not, under any normal circumstances, a serious competitor with the standard, established Mandarin frame. Thus the switch, under any normal circumstances, is not a possibility.

It should be noted, though, that circumstances are not always 'normal' and so the incompatibility of a particular switch with the requirements of SS, which is responsible for the unacceptability of the switch, does not entirely rule out its occurrence in performance. Processing is guided by syntactic principles, but real-time demands (not to mention whims) can lead to deviations from them. Such deviations should be accompanied by a recognition, possibly implicit, that something is not as it should be in the utterance (i.e. activation of negative value).

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3. For other code-switching work involving head-complement relations, see for example Belazi, Rubin, and Toribio, 1994; Di Sciullo, Muysken, and Singh, 1986; Mahootian & Santorini, 1996; Myers-Scotton, 1993, 2006; Toribio, 2001.

4. The exact mechanism behind such an ordering requirement, depending very much on one's specific syntactic theory, is beyond the scope of this discussion.

7.9 Conclusion

We suggested in a previous paper (Truscott & Sharwood Smith, 2017) that a theory of code-switching should not be a theory of code-switching; it should be a spelling out of the implications of a more general account of representation and processing, as they are understood within a specified cognitive framework. Here we have sought to establish an approach of this sort. This approach unifies the traditional 'why' and 'where' questions. We should emphasize here, as we have throughout, that what we are offering is a framework for understanding and researching code-switching, not a specific theory. A great deal of more specific development is needed, in all its aspects, in order to achieve a full understanding of switching. The hope is that the framework will facilitate such development.

Finally, one implication of this approach is that the phenomena of 'language control' actually extend beyond the area in which the term is commonly used. The phenomena seen in choice of language, including code-switching, can also be found in control of dialect and register. There is a need for research on switching between dialects and registers instead of languages. We suggest that the conception of internal context as developed here provides a useful framework for research of this sort.

8. Conclusion

In this chapter we extended the discussion of previous chapters by exploring the implications of the account for a number of prominent topics in bilingual processing, centered on the coactivation of representations from the bilingual's different languages. Our claim is that the MCF with its notion of internal context can offer insights into all these phenomena and suggest ways of further studying them.

CHAPTER 10

Internal context and attention, working memory, and effort

1. Introduction

Internal context is essentially a spelling out of the implications of an account of representation and processing within a specified framework, MCF in this case. This, we suggest, is the most promising way to pursue research and to interpret its findings. A theory of bilingual processing, or of any particular aspect of it, should not be a theory of bilingual processing but rather a spelling out of the implications of a general account of representation and processing within a given framework. This point also goes beyond bilingual processing to broader questions of the functioning of the cognitive system as a whole.

In discussing cognitive control and language control in Chapters 6, 7, and 8, we noted several cognitive phenomena that are intimately associated with control: attention, working memory, effort, and consciousness. The general point just noted should apply to these phenomena as well: A theory of attentional effects in bilingual processing, for instance, should not be a theory of attentional effects in bilingual processing but rather a spelling out of the nature of representation and processing. This is to say that it should be developed in terms of internal context. The same is true for accounts of working memory, effort, and consciousness. In this chapter we will develop these points for the first three phenomena, showing how our account naturally extends to these topics. For each we will start with a general cognitive discussion and then turn to its application to bilingual processing. Discussion of consciousness will occupy the following chapter.

2. Attention

As described in Chapter 6, attention has been intimately associated in the literature with cognitive control, either as a tool of control or as a controller itself, and so its status is important here, for cognition in general and specifically for its role in bilingual processing.

2.1 Attention and cognition

Sharwood Smith and Truscott (2014b) treated attention not as a genuine entity but rather as a useful abstraction from the factors that influence the current activation levels of representations and thereby determine which of them receive extensive and intensive processing. These factors are simply those that comprise internal context and cognitive control. The implication is that attention may be best understood through a study of the factors of internal context, particularly inherently internal context. Each of these factors – value, emotion, goals, and self – is clearly associated with attention. We attend to things that we value, positively or negatively, as well as things that evoke emotions, things that contribute to (or obstruct) active goals, and things with which we are personally involved in some way – things that engage the self. Given the centrality of these factors and the issues in the concept of attention, it may be best to say not that they guide attention but rather that attention simply *is* their influence on activation. This means treating attention not as a genuine theoretical entity but rather as a (possibly) useful shorthand for the influences described here.

Our approach to attention is consistent with the ideas of a number of previous authors. Damasio (2010, p. 203) refers to attention as a name for the focusing of processing resources on a single object, suggesting that he is reluctant to see attention as a genuine entity. In his theory, value does most of the work that would otherwise be assigned to attention. Baars treats attention as the gateway to consciousness. Unlike many others he prefers (at least at times) to see it "not as a separate system but rather as the name for the process of gaining access to global workspace [i.e. to consciousness] by reference to long-term or current goals" (McGovern & Baars, 2007, p. 200; but see also Baars, 1997). Krauzlis, Bollimunta, Arcizet, and Wang (2014) analyzed attention "as a byproduct of circuits centered on the basal ganglia involved in value-based decision making," eliminating the homunculus that commonly appears as the controller of attention. Note that "value-based decision making" is very much a matter of inherently internal context, involving goals (in the context of self) as well as value (with accompanying affect).

Much of the research and theory on attention has focused on selection of sensory input, especially visual, though the sensory focus is by no means definitional (see, for example, discussion of internal vs. external attention by Chun, Golomb, & Turk-Browne, 2011). Standard thinking, based especially on Desimone and Duncan (1995), is that attentional effects in perception are a matter of competition among perceptual representations, with relative activation determining which are ultimately selected. The relative activation is strongly influenced by a frontoparietal, or frontoparieto-cingulate attentional network. As described in Chapter 6, this network can be at least tentatively identified with goals (prefrontal), value and emotion (cingulate), and integration of perceptual input (parietal) – elements of internal context.

Overall, the function of these elements is to selectively activate representations in the various modules, making those representations more available for processing. This looks a great deal like the control function of attention.

2.2 Attention and bilingual processing

The problems with the concept of attention and the virtues of reconceptualizing it in terms of internal context can be seen in some uses that attention has received in SLA theorizing, notably in Richard Schmidt's (1990, 1993, 1995, Schmidt & Frota, 1986) influential work on consciousness. This work revolved around his Noticing Hypothesis, which claimed that a particular type of awareness of the targets of learning is necessary for successful language acquisition. In his theorizing, attention played a major role because it was largely equated with consciousness, an idea that is problematic in itself (Anderson, 1995; Baars, 1997; Koch & Tsuchiya 2007, 2012; Lamme, 2003; van Boxtel, Tsuchiya, & Koch, 2010). In later work Schmidt (2001) emphasized attention rather than awareness, with the claim that "for all practical purposes, attention is necessary for all aspects of L2 learning" (p. 3).

The problem with this claim is that the word 'attention' can mean a great many different things, including simply a basic level of alertness. Schmidt discussed the various meanings at some length and made the ambiguity of the term clear, but did not make clear just what he meant by 'attention' when he said that it is necessary for L2 learning in general or that it is necessary for various individual aspects of L2 learning. The hypothesis that attention is necessary for learning touches on important features of cognition, and it has the appearance of being a clear idea because we have an ordinary language concept of attention and so believe that we know what it is. But the reliance on 'attention' means that this seemingly strong hypothesis actually has no clear content (for further discussion, see Truscott & Sharwood Smith, 2011).

The conclusion, we suggest, is the same one indicated by work within psychology. It is best to avoid the concept of attention, seeking instead to understand the phenomena in terms of internal context and the factors of which it is composed. The 'selection' attributed to attention is a product of goals, in the context of CS selves, and value and emotion, in the context of the AfS self. These factors establish an internal context in CS for bilingual processing. Attention in perception is about these factors producing selective activation of representations in POpS and thereby encouraging a global synchronization with a particular (constantly shifting) focus. This focus determines what speech will be processed, how it will be processed, and what other features of the situation and the non-linguistic and paralinguistic features of the interlocutor(s) will play significant roles in the processing. A statement that the person is attending to these things is an intuitively satisfying description of the phenomena, but it is not an explanation. For that we have to focus on the factors that are responsible for the phenomena, i.e. the internal context. These are the factors that are responsible for the character of any particular instance of speech processing.

3. Working memory

Working memory is commonly associated with control, as described in Chapter 6, and this relation is readily explained in terms of the influence of internal context on processing. In this section we will explore this point, first for cognition in general and then for bilingual processing.

3.1 Working memory and cognition

WM, as we characterized it in Chapter 2, is simply sets of currently active representations. Each module has its own, local WM, consisting of the representations that are currently most active in its store. More important for present purposes, though, is the global working memory (GWM), and this will be our focus. It is also necessary to incorporate affective processing in the concept of working memory, which we will do below.

3.1.1 *Working memory and POpS synchronization*

Global working memory (GWM) is a product of the global synchronization of processing centered on perceptual output structures POpS).[1] Thus, when we speak of the association of WM with control we are talking about GWM, which more or less corresponds to the standard sense of 'working memory'. The representation that is the current focus of the synchronization has the highest activation level and so is necessarily 'in WM', to revert to standard terminology.

But GWM includes more than this one maximally active representation. We should also include recently focused representations that have declined in current level but still retain a high enough level to make them highly available (i.e. 'in WM'). Setting aside affective processing, it is doubtful that the activation levels resulting simply from local synchronization, within a module, can ever approach those produced by global synchronization, though this possibility cannot be

1. Recall (Chapter 2) that GWM is not a genuine entity in the MCF but rather a useful abstraction characterizing the way that the most highly active representations influence processing.

entirely ruled out. In any case, working memory as it is normally understood is a matter of cognitive control in that it is selective activation of representations in the service of goals, making those representations especially available for processing. The activation is brought about in the familiar way: by inherently internal context operating on the stage set by outside-in context.

3.1.2 *Working memory capacity*

Research on working memory capacity (WMC) has a natural place in this account. The nature of capacity limits has been a rich area of research in recent years, both in second language acquisition (e.g. Juffs & Harrington, 2011; Linck, Osthus, Koeth, & Bunting, 2014; Szmalec, Brysbaert, & Duyck, 2013; Wen, 2014; Wen, Mota, & McNeill, 2015; Williams, 2012) and in cognitive research in general (for review, see Oberauer, Farrell, Jarrold, & Lewandowsky, 2016). We will focus on the latter in this section and then, in Section 3.2.2, apply the understanding gained here to the topic of bilingual processing. Our approach shows a strong resemblance to prominent theories in this area, differing in that it places the ideas within a particular, relatively explicit view of the cognitive system as a whole. In exploring these points we will focus on the influential work of Cowan, Saults, and Blume (2014).

These authors were particularly interested in the relative contributions of peripheral (code-specific) capacity and central capacity, the latter available for different functions as needed. They concluded, contrary to their earlier view, that most of overall capacity (the 3–5 items of Cowan, 2000) is peripheral; central contributes only about one item. This distinction readily translates into our approach: Peripheral capacity reflects the local WMs of the individual modules; central capacity is the GWM. WMC is thus the combination of (a) module-internal activation and (b) activity brought about by the integrated activity of goals, self, value, and emotion. This integrated activity is cognitive control. The importance of peripheral WMC is expected given the assumption that the mind is highly modular. For Cowan, Saults, and Blume (2014), their notion of central capacity is about the limits of attention, which is in effect acting as controller, while peripheral is based on local interference resulting from the needs of different representations to include common features. The in-depth review by Oberauer, Farrell, Jarrold, and Lewandowsky (2016) found this approach consistent with research findings. These ideas again fit well with our approach: The attentional limits represent the nature of the synchronization while the interference occurs within the individual modules.

The one-item central capacity found by Cowan, Saults, and Blume (2014) is part of a general recognition in the literature that a single attended item enjoys a special status in WM. Oberauer's (2009; Oberauer & Hein, 2012) account of WM, for instance, hypothesizes that a small number of items occupy a "region of direct access", making them available for use in processing, and attention focuses on a single item within this region, making that item especially available (see also Allen, Baddeley, & Hitch, 2014; Garavan, 1998; McElree, 2006). This one item, we suggest, is the one representation that is the focus of the synchronization underlying the GWM. Cowan, Saults, and Blume suggested that during working memory maintenance attention focuses on a single item but during encoding it may be able to zoom out to encompass a few items, which can be combined in the focus of attention to make a new representation. In our terms, a few items can be activated, either simultaneously or successively (cf. Cowan, Saults, & Blume's discussion of rotating attention), making them especially available to the local processor and thereby creating the potential for it to combine them to form a new representation.[2] When the GWM synchronization focuses on one of these representations, either a newly created one or one of the originals, that representation becomes especially active and can be maintained in that state for a time.

3.1.3 *Affective working memory*

Given our conception of working memory, AfS necessarily has its own WM. There have been past proposals for an affective working memory (Davidson & Irwin, 1999; Gooding & Tallent, 2003; Kaschub, 2008; Luciana, Burgund, Berman, & Hanson, 2001; Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005; Mikels, Reuter-Lorenz, Beyer, & Fredrickson, 2008), and the logic of such a proposal is compelling: The function of WM is to keep relevant information available for use in processing when there is no external elicitor of that information currently present, and we know that an emotion can continue to guide processing even when the thing that elicits it is not present. Substantial empirical support for the hypothesis can also be found in the sources just cited.

This affective working memory can be analyzed as synchronization of processing within affective structures, with AfS understood as the seat of all the lower-level factors of internal context. However the details are treated, affective working memory inevitably exerts a strong influence on processing quite generally, as it is about affective representations that have especially high current activation levels. This is, again, internal context.

2. How the combining occurs is an interesting question that is beyond the scope of this book (see Chekaf, Cowan, & Mathy, 2016; Gao, Gao, Tang, Shui, & Shen, 2015; Shen, Xu, Zhang, Shui, Zhang, & Zhou, 2015; Zhou, Zhang, Ding, Shui, & Shen, 2016). For an interesting example of non-incorporation of a perceived feature that is not the focus of the integration, see Chen, Swan, and Wyble (2016).

3.2 Working memory and bilingual processing

Working memory has been a significant subject of research within SLA (e.g. Juffs & Harrington, 2011; Linck, Osthus, Koeth, & Bunting, 2014; Sharwood Smith, 2017d; Szmalec, Brysbaert, & Duyck, 2013; Wen, 2014; Wen, Mota, & McNeill, 2015; Williams, 2012). It has also been studied extensively in bilingualism research, with a focus on possible advantages or disadvantages of bilingualism (e.g. Bialystok, Poarch, Luo, & Craik, 2014; Cockcroft, Wigdorowitz, & Liversage, 2019; Grundy & Timmer, 2017), a topic that we briefly considered in Chapter 7. Here our concern is with understanding the place of working memory in bilingual processing in terms of internal context. We will look first at the role that CS plays as the crossroads of linguistic processing and the internal context in which it occurs. We then turn to the most studied aspect of working memory within SLA, namely working memory capacity. Because of its importance in the field, we will have much to say about it. We then conclude with a look at the place of affective WM in bilingual processing.

3.2.1 *Working memory and conceptual structures*

We have previously described CS as the crossroads of linguistic processing and its internal context. Its role as the stage for internal context can readily be seen in terms of working memory as we have characterized it. Each module has a local WM, consisting of the currently active representations in the store of that module. The local WM of CS is the immediate context for linguistic processing. This local CS activity inevitably reflects the activity of the GWM, based on current and recent global synchronization, but the local synchronization in CS establishes the dominant outside-in context for linguistic processing, in the form of highly active CS representations. These representations dominate the stage on which the influence of the inherently internal elements is played out.

One such representation that is particularly important for bilingual processing is the identity of the interlocutor. If it is in CS working memory, it is likely to have a significant influence on current linguistic processing, possibly determining which of the bilingual's languages is used, for instance. Its presence in conceptual WM is likely to be the consequence of visual and/or auditory input – the sight of the interlocutor's face and/or the sound of his/her voice. In other words, the source is active VS and/or AS representations. The activity of these representations spreads via interfaces to CS, resulting in activation/construction of representations of the person. These representations then constitute the local, conceptual WM, or part of it.

In a case like this we would expect the visual and auditory representations of the interlocutor to be in the GWM at some point. If they were not, this would mean, in traditional terms, that no attention was paid to the speaker and there was no awareness of him/her. The result would be relatively low activation levels for the perceptual representations and so only limited influences on CS processing. The speaker's identity would not be part of conceptual WM and so would play little if any role in subsequent linguistic processing. Thus GWM has a very important, if indirect role in the internal context of bilingual processing, crucially contributing to outside-in context.

Perhaps the most important element of outside-in context is a conceptual representation (or representations) of what was just said to the person or in his/her presence. In this case the input to CS is largely via the linguistic modules. The other person's utterance, expressed in patterns of sound waves, is represented in auditory structures (i.e. processed in a POpS module). This AS representation then serves as input to PS and then SS. The ultimate result of this linguistic processing is the message, i.e. a conceptual representation of the meaning of the utterance, and this representation serves as part of the immediate context for subsequent linguistic processing.

While construction of the CS representation in this case is more removed from POpS than in the previous example, the role of GWM is no less important. If the AS representation was never in the GWM – was never the focus of the POpS synchronization – its effect on processing in the linguistic modules is likely to be quite limited or even non-existent. The result in CS will then be either no CS reflection of the utterance at all or an impoverished representation with a low current activation level; in other words, the representation will not be in CS working memory.

3.2.2 *Working memory capacity*

Individual variation in working memory capacity (WMC) has been a central concern in research on WM and especially on its practical application. Surprisingly little understanding exists, though, of exactly what it is, in terms of the cognitive system and its workings: The factors underlying WMC and its variability remain obscure (see Baddeley, 2007). In SLA, research on the relation between WMC on the one hand and L2 processing and learning on the other has produced inconsistent and often confusing results (for reviews, see Juffs & Harrington, 2011; Linck et al., 2014; Szmalec et al., 2013; Wen, 2014; Wen, Mota, & McNeill, 2015; Williams, 2012). This confusion is commonly attributed to the use of differing measures and the large number of potentially relevant variables. A more fundamental problem, we suggest, is the absence of a good theoretical foundation (see also Wen, 2015). Our framework, with its explicit concern with the nature of cognitive architecture and processing, might offer a way forward, though the preliminary character of the proposal should be stressed.

3.2.2.1 *What is working memory capacity?* Two general types of tasks are commonly used to measure WMC. In *simple span tasks*, the person is given a sequence of words or other items and is then expected to repeat them. The person's working memory span is how long the sequence can be without loss of the items to be remembered. *Complex span tasks* require the person to do something else while holding on to the target items. The popular listening span and reading span tasks, for example, require subjects to comprehend a series of sentences and retain the final word of each.

From the standpoint of our framework, the first requirement in performance of a linguistic span task, simple or complex, is to maintain active POpS representations of the targets long enough for phonological structures to extract the relevant (phonological) information from them. Assuming the use of simple, familiar items, this is a very minimal demand, though use of an L2 could make it more demanding, at least for low-level learners. Successful extraction of the phonological information means activation of a corresponding representation of the item's phonological form, in PS. The PS-SS interface then activates a corresponding SS representation, which triggers activation of a CS representation of the item's meaning, via the SS-CS interface. This conceptual representation is also likely to receive stimulation directly from the original POpS representation, given the existence of interfaces between CS and the perceptual output modules.

Holding on to a word during a span task requires maintenance of this active chain of representations at a sufficient level of activation and for a sufficient time to allow its subsequent use for reciting the word. Memory for a list of words requires this sort of maintenance for each item while subsequent items are being processed.[3] This is the phonological (auditory) loop, as the concept applies to linguistic stimuli. What is traditionally called phonological working memory is thus about the maintenance of active chains of representations in this loop.

Executive factors have an important role in this process. These factors consist of the goals and values that guide thinking and behavior. When a particular goal representation is active, inevitably in conjunction with value, this activity will raise the activation levels of representations that are associated with the goal. In working memory tasks, the immediate goal is to remember certain items; representations of those items are naturally stimulated as a result. This is the executive aspect of WM. Because goals and value are also central factors in the POpS synchronization that yields perceptual awareness, executive control is intimately associated with consciousness.

3. An additional complication, which we will only note here, is the need to maintain serial order information, probably in CS.

If these executive factors are set aside, the auditory/phonological aspect of WMC then consists of all the remaining influences on activation of the representations in the loop – the varying abilities of the auditory, phonological, and syntactic modules to maintain activation of representations that are not currently involved in processing, plus the influences that each module has on the others. It must also include CS factors. Importantly, we should expect the CS and especially AS contributions to be substantially greater than those of PS/SS, due to contrasts in typical activation levels.

3.2.2.2 *Some implications of the MCF account of working memory capacity.* One implication of the preceding discussion is that simple span tasks, commonly treated as measures of phonological WM, also include an executive component, in the form of the selective activation produced by active representations of goals and value. In other words they are actually not just about phonological WM pure and simple. The presence of executive control in such tasks seems intuitively clear – the person is deliberately attending to the target items and trying to remember them. Thus, while executive and 'phonological' WM can be distinguished in principle, in practice their effects always overlap and there is no pure measure of one or the other.

Complex span tasks maximize the role of the executive component, because the active chain must be maintained in the presence of additional linguistic processing, namely activation and construction of additional representations in each of the relevant modules. Under these conditions, local influences work strongly against maintenance of active representations that are not part of the additional processing. Simple span tasks reduce this factor and therefore make better measures of the local factors – Baddeley's phonological loop. This overlap between executive and local 'phonological' factors might provide a partial explanation for the often inconsistent and confusing findings in research on WMC.

PS and SS should have a relatively limited relation to common measures of WMC, because of their inherently modest activation levels and because of the separation between them and the elements of inherently internal context, the 'executive' elements of the system. SS representations are directly connected to CS representations, but not to goals. The relation between SS and CS is specifically one of form to meaning: The CS representation is the meaning of the SS representation with which it is coindexed. This leaves no room for direct influence of a CS goal representation on PS/SS processing. We suggested previously that value and other AfS representations do not have direct connections to PS and SS. Taken together, these points suggest that the executive element measured in WM research should have only a limited, indirect role in the workings of PS and SS.

This means that WMC, as it is normally measured, is mainly about perceptual and conceptual WM and the synchronization of the former, with some more limited influence from adjacent modules. The expectation, then, is that WMC as it is normally measured will be quite relevant to use and development of conceptual linguistic knowledge, just as it is with any other conceptual knowledge, but will have only a limited relation to the use and development of knowledge in the specialist linguistic modules. The relevance of WMC might in fact be considered a (not entirely pure) measure of the extent to which a person's language use relies on conceptual linguistic knowledge.

We should thus expect research to find WMC, as it is commonly measured, playing only a limited role in grammatical processing, which relies primarily on SS. In their review, Juffs and Harrington (2011) emphasized the frequent failure to find a relation between WMC and what goes on in syntactic processing (see also Juffs, 2015). Similarly, Williams' (2012) review included the conclusion that "there is surprisingly little evidence for WMC constraints on on-line L2 [or L1] syntactic processing" (435), suggesting that syntactic processing is modular (see also Williams, 2015). These findings are expected given our account of working memory. For processing in SS, the synchronized perceptual working memories are important as the input for processing and learning, but the demands that a linguistic module makes on them are relatively limited. CS capacity is important for language-related processing that goes on outside the primary PS-SS-CS chain, but much less so for processing in SS. So again WMC, as commonly measured, should have only limited relevance for processing in the linguistic modules.

One implication of this conclusion is that learners' proficiency levels should be related to the involvement of WMC in language tasks. In the early stages of learning, especially formal classroom learning, knowledge *about* language, which is found in CS, will often substitute for poorly developed PS and SS knowledge. In this situation we should see the strongest relation between WMC and success. And this is the typical research finding (French, 2003; Gathercole, 2006; Hummel, 2009; Masoura & Gathercole, 2005; Winke, 2005). This association of WMC with early stages of learning reflects more proficient learners' increased reliance on the linguistic modules in place of conceptual linguistic knowledge, and hence their reduced demands on WMC.

The length and complexity of the sentence being processed should also influence the extent to which WMC is relevant to language use. When interpretation requires that information appearing early in a long, complex sentence be used much later, the linguistic modules may not be able to keep the information active long enough and so the ability of the other modules, including executive WM and the AS, becomes significant. These are the cases in which patients with very limited spans show problems in language comprehension (Vallar & Baddeley, 1984, 1987), because the linguistic modules do not receive the external support they need.

The account also implies that WMC is associated primarily with explicit processes. When learners are relying on CS, processing (and therefore learning) is typically much more explicit than when the linguistic modules are prominently involved (see Truscott, 2015a, 2015b). So WMC should be especially associated with explicit learning. This is the conclusion that Williams (2012) reached in his review, that it is specifically studies of explicit learning that find a relation between WMC and second language learning.[4] A significant clarification is that when the processing involves specifically perceptual output structures and conceptual structures, it is not *necessarily* explicit. Leung and Williams (2011) found implicit learning of form-meaning mappings using a methodology, involving artificial laboratory tasks, that probably studied the POpS-CS route. The point is that both this route and traditional WMC are strongly associated with explicit processing and so the association between them in research findings is expected.

Finally, the language in which the span task is carried out should influence both processing routes. If a language has not been mastered, representations in PS and SS are not well developed, nor are the AS and CS representations that are useful for that language and the direct connections between them. Processing of items in that language is therefore inefficient, in both routes. The implication is that for low-level learners WMC should be considerably smaller when measured in the L2 than in the L1 and this contrast should decline with increased proficiency. These expectations match research findings (Gass & Lee, 2011; Service, Simola, Metsänheimo, & Maury, 2002; van den Noort, Bosch, & Hugdahl, 2006).

3.2.2.3 *Conclusion.* Perhaps the most important point of this discussion is that the study of working memory capacity is best conducted in the context of a general framework specifying the nature and operation of the cognitive system. We have sought to show here how WMC can be understood and studied in the framework provided by MCF, as the interaction of various modules each with its own memory store and therefore its own working memory. The approach directly predicts/explains the following:

- Executive and phonological WM, as they are commonly understood, are both involved in both simple and complex span tasks, differing in degree.
- WMC, as it is normally measured, is mainly about perceptual and conceptual WM, with only a limited relation to syntactic and phonological components of the system.

4. Linck et al. (2014) found a fairly substantial relation between WMC and L2 processing and learning but did not distinguish types of processing and learning as Williams did. Nor did Szmalec et al. (2013), who took a positive view of the relation on theoretical grounds but were agnostic regarding the evidence.

- The involvement of WMC in language processing is strongly and inversely correlated with proficiency in the language being used.
- The involvement of WMC in language processing is directly correlated with the length and complexity of the sentence being processed.
- WMC is especially associated with explicit processes.
- Use of an L2 for measurement of WMC yields significantly lower scores for low-level learners but not for proficient speakers of the language.

3.2.3 *Affective working memory in bilingual processing*

Affective WM, as we described it above in 3.1.3, is simply the currently most active representations in AfS, notably including representations of value and of specific emotions. Because of their high activation levels, these representations are likely to be a prominent part of the internal context of processing, including linguistic processing. We have described throughout the book this role of affective representations as internal context, with their strong indirect influence on linguistic processing based on their strong direct influence on CS. In terms of working memory, this means that affective WM influences conceptual WM, in essentially the way that POpS representations influence conceptual WM, and therefore helps to establish the internal context for linguistic processing. The strength and importance of this influence is apparent from discussion in the previous chapters, as well as in the general literature on bilingualism.

4. Cognitive effort

The sense of effort is closely associated with control, i.e. with the function of inherently internal context. The two cannot be equated, as control processes can be automatic, with no sense of effort (cf. the 'effortless control' of Naccache et al., 2005; also the 'effortless attention' of Bruya, 2010). But the association is nonetheless clear. So it is important to consider here what effort is and how it fits into our account, for cognition in general and specifically for bilingual processing.

4.1 Effort and cognition

In recent years effort has become a significant topic in cognitive and neuroscientific research (see Inzlicht, Shenhav, & Olivola, 2018; Kurzban, 2016; Shenhav et al., 2017; Westbrook & Braver, 2015), though it is still not well understood. Perhaps the most salient feature of effort is that people tend to minimize it in their activities, seeking less effortful ways to accomplish their goals or simply abandoning an activity when it becomes too effortful. Thus, effort is commonly analyzed in terms of costs and an in-built tendency to minimize them. In this section we will explore an MCF approach along these lines, based on the activity of goal representations and their place in the goal-based self.

4.1.1 *What is cognitive effort?*

The experience of effort is associated, again, with top-down control, based on goals. We feel a sense of effort when we are trying to do something – i.e. achieve some goal – and it is not readily, smoothly accomplished. The attempt to communicate a difficult idea using a weak second language is an example. We have a goal of communicating the idea and that goal is not readily achieved, with the result that the goal must be maintained for an unusual length of time (or abandoned). The sense of effort, in this case and in general, is associated particularly with the involvement of self in control and with a self-based sense of volition, the feeling that *I* am controlling my thoughts and actions in order to express that idea. An account of effort should thus be in terms of goals and their activity as components of the goal-based self. Specifically, it should hypothesize a mechanism to limit this activity. This mechanism is best attributed to AfS, where all the basic life regulation mechanisms are found.

A natural hypothesis is that a representation exists in AfS specifically for the purpose of constraining strong sustained goal activity; i.e. for minimizing effort. This affective representation might be labelled !effort!. Strong goal activity in CS activates it, with cumulative effects, creating a sense of effort. Thus, the active goal of expressing that idea in the L2 activates !effort! and the longer the goal remains active the higher the activation level of !effort! will become. The fact that effort is inherently aversive – a recurring theme in the literature – indicates that negative value is a component of the representation (we will consider below the senses in which effort is *not* aversive).

The effect of the !effort! representation in limiting strong sustained goal activity can be explained in terms of the type of veto representations we considered in the discussion of inhibition (Section 3.3.3 of Chapter 6). When the activation of !effort! spreads, via the AfS-CS interface, to a veto representation, the veto becomes a part of processing in CS, combining with already-active representations to form a representation that says in effect “Don’t do this”. In the case of the person struggling to express an idea in a weak L2, this representation says in effect “Stop trying to say it in that language”. This representation then acts as a competitor with the active goal representation, which promotes continuation of the attempt.

Following standard assumptions of MCF processing, the CS processor will combine the veto representation with whatever other representations are most active. One implication is that the veto will apply especially to currently dominant goal representations. Another is that if this domination continues for some time the opposition from the veto representation will steadily grow. The upshot is that when a goal is continuously pursued, the pursuit can become increasingly difficult and, because the increasingly active !effort! representation contains negative value, it can also become increasingly unpleasant, as can be seen in the facial expressions that often accompany sustained effort.

4.1.2 *When is processing effortful?*

On this view effort is a continuous variable. It is present whenever goal activity is present, though very often at a level too low to yield any conscious experience of the effort (recall that a representation is the object of consciousness specifically when its current activation level is especially high). It plays a significant role in processing when this level is relatively high; it becomes a dominant factor when the level is extremely high. The interesting questions then are about the circumstances in which these levels are reached.

High levels of effort are about sustained high levels of activity in goal representations. These in turn are strongly associated with the extent to which a goal continuously dominates the goal-based self. When sustained dominance is present, the result is increasingly strong activation of !effort! in AfS and therefore a sense that effort is being exerted in the service of the goal. This is the typical product of difficulty involved in the task, preventing smooth transition from main goal to subgoals and among the subgoals. For the purpose of trying to say things in the weak L2, these subgoals are the specifics of expressing the idea, such as selecting appropriate words, ordering them properly, and pronouncing them properly. If the process gets stuck on any of these, that subgoal and/or the main goal will remain highly active. Sustained dominance can also result from the influence of competition from rival goals and/or bottom-up influences, if these factors are strong enough to prevent or delay achievement of the goal but not strong enough to result in its abandonment. If the goal is either achieved or abandoned, the goal representation will lose its dominance and its activation level will fall. The sense of effort is then lost.

To further illustrate these points, we return to the example considered in Chapter 8 of a person trying to write a paper at a coffee shop while a conversation is going on at the next table. CS is dominated first by the goal of writing the paper and, more often, by subgoals and other representations involved in executing the goal. The presence or absence of effort will reflect the ease with which dominance passes from one to another.

In the ideal case, dominance of CS passes smoothly from main goal to subgoals and among the subgoals, with little or no difficulty or distraction, until the task is accomplished. As a result, there is no sustained domination by any goal representation and therefore no sense of effort. More realistically, though, effort can enter in several ways. One source is inherent difficulty of the task. The process can easily get stuck on the execution of a particular subgoal, keeping that goal highly active, or the failure of a subgoal can lead to a resumption of dominance by the main goal, in effect a seeking after subgoals that will move the process forward. In either case a goal representation continuously dominates the goal-based self for some time, resulting in increasing activity in the !effort! representation and an increasing sense of effort associated with that goal.

Another likely source of effort is distraction and the need to deal with it. The nearby conversation constitutes sensory input that can interfere with execution of the goal, disrupting the smooth transitions among the relevant goals and other CS representations. If the distraction is not so strong as to terminate the goal-based processing entirely, dominance of CS will stay with one goal or repeatedly return to it. The experience then is of effort being exerted to carry out that goal in the face of the distraction. If the distraction is strong enough that its representations come to dominate CS, the sense of effort related to the previous goals is lost, for at least as long as that new dominance continues.

The challenge to the original goal can also come from internal sources rather than immediate sensory experience. Strong activity in representations of current financial problems or of a recent quarrel with a family member, for instance, can have the same effect as an intrusive conversation, preventing the original goal from being executed. If this goal nonetheless retains its dominance of the self, a sense of effort will be experienced. If it loses this dominance to the rival thoughts and memories, the experience will be of these thoughts and memories and there will of course be no sense of effort associated with the abandoned goal.

Either source of distraction, internal or external, can activate goals that will then compete with the paper-writing goal(s). An interesting word or phrase in the conversation might result in a goal of finding out what is being said about it. Active memory of the family quarrel might yield a goal of resolving it. If one of these alternative goals triumphs over the original goal, the sense of effort associated with the latter will of course disappear as well, possibly replaced by effort associated with the replacement goal.

Finally, we should note the active role of the !effort! representation in examples of this sort. When it is strongly activated, this activity will create a challenge, an increasingly important one, to the continuing dominance of the goal that led to it. Specifically, the longer the paper-writing goal or one of its subgoals maintains its dominance in CS, the more strongly it will be opposed by a veto representation in CS.

4.1.3 *Effort and positive value*

Inzlicht, Shenhav, and Olivola (2018) pointed out an apparent paradox in the nature of effort. While it is costly, as many have noted before, it is also valued. People often seek challenging tasks that require effort and they often feel better about an outcome if its achievement required a significant effort. In our framework this positive value has two sources.

First, effort is valued because it reflects the activity of goals that are valued. Here we mean 'valued' both in the intuitive sense and in the more specific sense that the positive value representation in AfS is coindexed with the goals and is therefore active whenever they are active. If a goal is sufficiently active to yield a sense of effort then substantial activation of positive value should also be present.

The second way in which positive value is associated with effort involves the meta-self. People generally like to believe that they have positive characteristics like hardworking, reliable, clever… These are components of the meta-self, activated when the goal-based self is doing challenging things, i.e. things that yield a sense of effort. Thus the frequent association of effort with positive value makes sense, despite the fact that negative value is a component of the !effort! representation.

4.1.4 *Effort and volition*

This account of effort, in conjunction with that of volition presented earlier, implies a close association between the two. In Chapter 8 we suggested that volition is consistency between current thought and behavior on the one hand and the current state of the goal-based self representation on the other. Effort is essentially a reflection of the self's attempt to make processing and behavior consistent with its current state, particularly with the goal that currently dominates self. The more the self representation as a whole is involved in carrying out the goal the greater the sense of effort will be. Thus, effort is associated with activity of the goal-based self, accounting for the fact that activity which involves effort is most clearly *my* activity; the more effort exerted, the stronger the sense that *I* am doing it. The presence of a sense of effort probably implies that the action is volitional, and while volitional action does not have to be accompanied by a sense of effort, it is very likely to be.

4.2 Effort in bilingual processing

Effort, as described above, is about a particular goal representation continuously dominating the goal-based self, and therefore CS, resulting in ever-increasing activation of the !effort! representation in AfS. The dominant goal is the person's current intention. This continuous domination occurs when the goal has not been achieved and has not been abandoned. Good examples can be found in bilingual processing. Here we will focus on the goal of using one particular language rather than another, specifically on relatively sustained use of the chosen language. The unresolved state of the goal, key to the presence of effort, can result from three overlapping factors: inherent difficulties in carrying out the task, outside-in contextual influences opposing the goal and its execution (i.e. distractions), and the activity of opposing goals.

It should be kept in mind throughout that in speaking of decisions to speak a particular language or of effort involved in doing so, we are not appealing to an unanalyzed agent, a homunculus. We are assuming the account of volition just described (see also Section 4 of Chapter 8).

4.2.1 *Goals, effort, and effortless bilingual processing*

Effortful use of one language rather than another inherently involves an intention; in other words, the goal-based self is dominated by a goal of using that language. This intention involves, almost by definition, the language representations in CS, such as MANDARIN or ENGLISH. Effort arises when this goal continues to dominate for some time, because of distraction, difficulty of the tasks involved in carrying it out, or active opposing goals blocking or hindering its execution.

Consider the case, originally presented in Chapter 8, of an oral English class made up of students who share a common L1, say Mandarin, and are expected to speak English in class. The students' linguistic behavior is typically influenced strongly by goals of improving English and, more specifically, practicing their speech, and also of pleasing the teacher and doing what is considered proper. Activity of these goals activates the goal of consistently speaking in English, which is likely to be active enough to dominate the goal-based self; in other words, achieving that goal becomes the intention of the student and abandonment of it would be perceived as a failure rather than just a change of plan.

Execution of this goal means activation of the various conceptual representations associated with English (i.e. those that include ENGLISH as one of their components) and their assembly into a coherent message representation. These various meaning representations then dominate CS, causing activation of coindexed SS and then PS representations and ultimately resulting in an English utterance. If no significant problems arise in this process, dominance of CS will typically belong to the sequence of message-related representations, not the English-use goal representation. In this case little or no sense of effort is experienced in relation to this goal. In the following sections we will consider the various problems that can occur in this smooth transfer of dominance from the overall goal to the representations involved in executing it, problems that can result in a sense of effort.

4.2.2 *Effort resulting from inherent difficulty of the task*

One such problem results from weakness of the L2. When CS representations associated with the L2 are activated, other representations, associated with the L1 or with both languages, will also be activated. They will in turn activate SS and then PS representations of the L1. These L1 representations have higher resting activation levels than their L2 rivals, so victory by the latter will require continuing support from the goal representation. In other words, the English-using goal will have to retain its dominance in CS while the SS and PS representations are being assembled. This sustained dominance results in continually increasing activation of !effort! in AfS, with an accompanying sense of effort. The need for this support is compounded by the lower efficiency with which L2 representations in SS and PS are assembled into appropriate overall representations, dictating that the components will have to be kept active for a relatively long time. The result is that considerable effort can be involved in using a weak L2, sometimes leading to abandonment of the goal and the use of the L1 instead. Abandonment of the goal is of course accompanied by the loss of a sense of effort. This is a matter of self-based processing being replaced by automatic, selfless processing, based on internal characteristics of the system.

4.2.3 *Effort and outside-in context in bilingual processing*

A switch from self-based to automatic processing can also be encouraged by outside-in contextual influences: Perceptual input selectively activates representations from one of the languages. Use of the other language might then require sustained activation of a goal representation and therefore become effortful.

The identity of the interlocutors can be an especially strong outside-in influence of this sort. Continuing with the example of an oral English class with Mandarin-speaking students, for these students representations of their compatriots are very strongly associated with linguistic representations of Mandarin, in SS and PS, and have little or no association with linguistic representations of English. Their activation, inevitable in this context, will thus directly activate the Mandarin representations, via the interfaces, encouraging use of the L1. If the student is to use English instead, sustained activation of the goal in CS might be necessary. Its activity is then likely to be accompanied by a sense of effort.

At the same time, though, other contextual factors can support the use of English, in the same way that interlocutor identity supports the use of Mandarin. The classroom setting, in particular, has been associated with English in past experience, so contextual representations of the classroom are coindexed with L2 linguistic representations and therefore contribute to their activation. The same may be true of the teacher's presence, especially if this particular teacher is identified as someone who cannot or normally does not speak Mandarin. If such factors are sufficient to overcome the contrary influence of the interlocutor factor, the student will not experience any effort in sticking to English. A limitation on this conclusion is that contextual factors interact with the possible difficulty experienced in using the L2, described above.

These cases fall under the Complementarity Principle (Grosjean, 2010). Through past processing experience, some contextual factors have become coindexed with representations of one language and some with representations of the other language. These connections exert an important influence on language use. When their influence is the dominant factor, we have automatic, selfless language processing, and so there is no sense of effort accompanying their operation (though when they act in opposition to a dominant goal they can yield a sense of effort in the maintenance of that goal).

4.2.4 *Effort and goal conflict in bilingual processing*

There is another way in which dominance of the English-use goal representation can be sustained and a sense of effort produced: Opposition from an alternative goal gets in the way of achieving the dominant goal. Here we are talking about alternative goals that entail use of the L1, or avoidance of the L2.

One such goal is successful communication. A student will sometimes not know how to accurately communicate a particular thought in the weaker language but have no difficulty making the other students understand it in the L1; the goal of communicating can then compete with the goal of practicing English. The former can become especially active when students are involved in an engaging communicative language task which takes on a life of its own, independent of its language learning function. In such cases the dominant goal faces significant opposition and sticking to English becomes effortful, simply because the goal representation remains highly active when the rival goal blocks smooth transition to the subgoals of carrying it out.

4.2.5 *Effort as internal context*

Whenever effort is present – i.e., the !effort! representation in the affective module is active – it acts as an additional element of internal context, a controller influencing processing elsewhere, including bilingual language processing. Its effect is to discourage the goal activity that has led to its activation. In the case of bilingual processing this can mean working against the intention to stick to a particular language. Abandonment of the goal may be especially likely when the target language is weak and communication in that language becomes challenging. In this case the !effort! representation receives additional stimulation from the need for more sustained focus on the representations being used. Its enhanced activity then further encourages abandonment of the goal of using the L2. Intuitively, extra effort is required to stick with it.

When the use of the L2 is abandoned, for whatever reason, the goal of using it can still retain sufficient activation to exert a continuing influence on processing, in effect becoming the opposition. When the L1 is being used as the result of outside-in factors, such as interlocutor identity, the L2-use goal may still come to dominate the goal-based self – the student feels that he/she should speak the L2, possibly with a sense of guilt at abandoning it. In this case there may then be an experience of effort in trying to alter the relatively automatic processing, possibly resulting in a return to the use of the L2. The same result could come more spontaneously when the student starts to deal with ideas that are less difficult to express, reducing the advantage of the L1 and the activation of !effort!.

4.2.6 *A note on code-switching and effort*

We have focused on sustained use of a language, rather than on brief switches between languages, because this is the kind of situation in which effort is most likely to be present. Sentence-internal switches, while often volitional, are typically not effortful. Insertion of a term from the non-target language might well represent dominance of the goal-based self, perhaps by a goal of impressing listeners, and so be volitional. But execution of the goal is likely to be relatively quick, presenting no opportunity for the !effort! representation to rise much in activation level. Exceptions can occur when making the switch is difficult for the person because of weakness in that language, leading to uncertainty about the appropriate word or challenges in pronouncing it properly. Effort could also arise if other active goals work against the deliberate switch, possible examples being concerns about comprehensibility or fear of a negative reaction from listeners. In the same way, avoidance of a switch could also be effortful. A dominant goal of sticking to the current language might be challenged by a goal of displaying knowledge of the other language, in which case effort could arise in suppression of potential switches.

4.2.7 *Conclusion*

Effort is about sustained goal activity, particularly as it relates to the goal-based self representation. When a particular goal representation is kept in a highly active state for some time – because it cannot be replaced by an appropriate subgoal and is not abandoned – the !effort! representation will gradually rise in activation level, creating a sense of effort. This is what happens when a bilingual effortfully sticks to one language over the other. In this effortful processing, some factors are supporting the continued use of the intended language (or else it would not be the intended language and would not be used at all), while others are working against this continued use. Whenever the !effort! representation is active, it will act as an additional element of internal context, influencing processing in approximately the way that other AfS representations do.

5. Conclusion

This chapter has explored some phenomena that play a central role in cognitive theory, and are therefore crucial for an understanding of bilingual processing. The conclusion is that all these phenomena can be readily explained in terms of internal context, as realized in the MCF framework. Goals, self, value, and emotion, operating on the stage set by outside-in context, are the factors that underlie attention and effort and are responsible for particular representations becoming the contents of working memory. In the next chapter we turn to another prominent phenomenon, consciousness, showing that it can be explained in the same manner.

CHAPTER 11

Consciousness and internal context

1. Consciousness and cognition

In the MCF, consciousness is not itself a controller or an element of internal context, but it is intimately associated with them, especially with strong varieties of control. The logic is that (a) a representation becomes the object of consciousness when its current activation level is extremely high, and (b) representations with high activation levels strongly influence processing in their own module and beyond. So the relation between consciousness and control is expected. The more specific issues are about the relations between awareness and each of the individual types of controller: goals, value, and emotion, along with the self representations that are composed of goals in the case of CS and of value and emotion in the case of AfS. We can also ask how consciousness is related to working memory and effort in the context of control. These are the topics of this first section. In the following sections we will apply the ideas to bilingual processing as such and then turn to the closely related topics of metalinguistic knowledge and translation and interpreting, understood in terms of the MCF treatment of consciousness and internal context.

1.1 Awareness and control from CS

Beginning with goals, awareness of control means, in principle, awareness of whatever goal is guiding current processing. There is probably no direct awareness of a goal representation,[1] as there is none of CS representations in general. We can be indirectly aware of a goal in the same way that we can be indirectly aware of other concepts, through perceptual proxies as well as accompanying affective experience. The natural proxy for a goal is linguistic; i.e. we can state the goal in words, as a full explicit statement or with key words. Awareness is then of the sound of the words, an AS representation. This is in fact a natural consequence of MCF architecture and processing. An active representation in CS activates, by way

1. A possible alternative is that the activation levels of goal representations can be sufficient to achieve a very limited sort of awareness. In terms of experience, it seems clear that perceptual and affective representations are objects of consciousness, but beyond this things become quite slippery, so some caution is required.

of the CS-SS interface, coindexed representations in SS, which leads to activation in PS and therefore AS as well. In other words, there is a natural tendency for activity in CS to be expressed linguistically, though a goal of speaking or not speaking could greatly influence the likelihood of overt expression occurring.

So when a goal is dominating processing, we are not literally aware of that goal, but may be able to acquire an indirect awareness of it. Whether a perceptual proxy actually becomes conscious or not is, as always, a matter of activation level: The more active, and enduringly active, the goal representation is, the more likely it is to stimulate construction or activation of a perceptual proxy and the more likely that perceptual representation is to reach the activation levels needed for awareness. The way it can reach such levels is through the global synchronization described in Chapter 6. And that synchronization is, again, brought about by the inherently internal factors of internal context operating on outside-in context.

The perceptual representation is not only a proxy for the active goal, though. If it becomes active enough to achieve consciousness – by becoming the focus of the global synchronization – it will then exert a strong and general influence on processing, simply because of this level. It will in effect be acting as a kind of controller, supporting and reinforcing the goal representation. This is one more way in which consciousness and control are related.

A crucial issue regarding goals and awareness is the place of self. We clearly have a conscious sense of self as actor, seeking to achieve goals, particularly in cases of effortful action. The goal-based self, as a large and well-connected representation playing an almost constant role in processing, presumably reaches fairly high activation levels, so this sense might be interpreted as awareness of this representation. The goal-based self is difficult to separate, however, from the affective self, which is certainly part of conscious experience. CS goals themselves do not appear to be part of phenomenal experience, while the affective elements – the sense of effort and emotions and value – clearly are. A natural conclusion is that the sense that *I* am exerting effort is primarily about the affective self rather than the goal-based self.

But this is not to minimize the role of the goal-based self. The ideas of effort and agency are only meaningful in the context of goal-directed activity, and the goals are part of the CS self. Thus, agency and effort are best analyzed in terms of coordinated activity of CS and AfS selves. This conclusion provides a partial answer, at least a tentative one, to the question raised in Chapter 4 regarding the extent to which we can meaningfully speak of a single 'self' rather than distinct 'selves'.

This account implies a range of possibilities for the relation between control and awareness. At one end of the continuum, the goal representation is very active, a state that probably requires a comfortable fit with the current state of a self representation. In this case the control it exerts will be quite strong and awareness of a conscious perceptual proxy is quite likely. At the other extreme, the goal representation is not active enough to have any significant control effect or to yield a conscious perceptual proxy. In between these extremes, there are more limited, but real, possibilities for control. And in this area the possibility of control without awareness arises. As expected, a number of studies have found that control can be exercised unconsciously; i.e., they have found cases in the middle region (see Capa, Bustin, Cleeremans, & Hansenne, 2011; Ferguson, 2008; Hepler & Albarracín, 2013; Lau & Passingham, 2007; Marien, Custers, Hassin, & Aarts, 2012; Suhler & Churchland, 2009).

1.2 Awareness and control from AfS

We can be and usually are directly aware of an emotion when it is acting as a controller, as is typically the case. The more highly active an affective representation is, the stronger its influence as controller *and* the more likely it is to be a part of conscious experience. Similar comments apply to value as controller. It appears in awareness as part of experienced emotions, giving them their positive/negative quality, and more directly in the feelings of rightness and wrongness. In Chapter 4 we noted the importance of value in decision making. In this context value appears in the feeling that the decision is right or is wrong – you really do want to order the cheesecake rather than the apple strudel (a sense of rightness, or positive value), or you need to reconsider that initial choice (a sense of wrongness, or negative value, possibly mixed with a lingering sense of rightness).

This kind of conscious experience represents an interaction of value with goals, in this case the goal of obtaining an optimal dessert. An active value representation realized in the (often subtle) sense of rightness can accompany the unconscious knowledge that the goal is proceeding properly. Typically, more salient is the sense of wrongness in the presence of perceived failure or deviation from the goal. This sort of awareness indicates that the goal is active and suggests the ability to verbalize it, i.e. to create a highly active perceptual proxy for it.

1.3 Consciousness, working memory, and internal context

In cognitive theory consciousness has always been closely associated with working memory – the thing we are currently aware of is currently in working memory. In MCF this association is between consciousness and *global* working memory; the contents of the local, module-based WMs will be the objects of awareness only if they are also in GWM. This association between GWM and consciousness is a natural consequence of the framework. Global working memory is the set of currently most active representations, while the current object of awareness is a representation with an exceptional current activation level. In terms of internal context, the contents of global working memory are the elements of the context that are most important at this moment; the representation that is the object of awareness is the most important of these currently important elements.

This analysis fits with the generally accepted view, based on research findings and ordinary experience, that the contents of WM include the contents of consciousness but are broader. When we are holding a list of words in WM, for example, only one word at a time is in our awareness, while the others recede into the background but remain available for use; in other words, they are still quite active but not enough to be the object of consciousness at the moment. Thus the relation of WM to consciousness makes sense.

To this point we have treated WM simply in its traditional 'cognitive' sense, focusing on perceptual representations and the conceptual representations associated with them. But the place of affect is no less important. In other words, we also have to consider the affective WM described in Chapter 10. Affective WM is synchronization of processing within AfS, yielding an extreme current activation level for one or more AfS representations. One implication is that those representations exert a very strong influence on processing quite generally – they are functioning as controllers and crucial elements of the current internal context. Another is that the most active of them is a current object of awareness, paralleling the current focus of the global POpS synchronization. This approach predicts an important aspect of conscious experience that is not often recognized: While it is impossible to be aware of two perceptual representations simultaneously, we can be simultaneously aware of a perceptual representation and an emotion, without any need for the two to form a single, coherent representation (see Truscott, 2015a,b).

1.4 Consciousness, effort, and internal context

Consciousness is also closely associated with effort. The !effort! representation itself is clearly present in consciousness, as is expected given that it is an AfS representation. The more interesting issue is possible awareness of the active goal that gives rise to the conscious experience of effort.

When the activation level of a goal representation is sufficient to yield strong activation of !effort!, i.e. to produce a sense of effort, it is almost certain to be a product of synchronized activity in the goal-based self, with a focus on that goal representation. The result is a very high current activation level, creating the possibility of a direct 'goal-within-self' conscious experience. We suggested previously that as a rule CS representations do not have sufficiently high activation levels to become objects of consciousness, consistent with the observation that they do not seem to have phenomenal qualities – they impact conscious experience only via perceptual proxies. But in the case of effortful pursuit of a goal the conscious sense of *trying to achieve something* does seem to have its own phenomenal qualities, beyond the familiar case of experiencing perceptual proxies – which presumably also plays a role in the conscious experience. But such intuitions are rather slippery and so caution is required.

Part of this sense of *trying to achieve something* is that the something, i.e. the particular goal being pursued, is at least close to awareness, if not actually part of it. This sense that a goal is 'close to awareness' is, again, quite slippery. It entails both a sense that the goal is readily available for verbal expression and a tendency to perceive experiences as facilitating or obstructing its achievement. Availability for expression is the familiar case of a highly active CS representation triggering activation or construction of a perceptual representation that in effect serves as a proxy for it in consciousness. The perception of experiences as positive or negative in relation to achievement of the goal is activation of positive or negative value – a natural consequence of a goal representation being highly active – producing the sense of rightness or wrongness.

2. Consciousness and the internal context of bilingual processing

The place of consciousness in second language acquisition has been explored in some detail within the framework (Sharwood Smith & Truscott, 2010; Truscott, 2015a,b; Truscott & Sharwood Smith, 2011). It is, again, not a controller but is *associated* with high degrees of control because a high degree of control reflects high activation levels and consciousness is the corollary of (very) high activation levels. The question we explored above was under what circumstances awareness of control exists and what this awareness consists of. The same issues arise in regard to language control.

2.1 Awareness of outside-in context in bilingual processing

First, we clearly can be aware of the outside-in context of bilingual processing. We are aware of the person we are speaking to and often of relevant characteristics of the person. We are also aware of the setting in which the language use occurs. In MCF terms, this is direct awareness of perceptual representations and, via these representations, indirect awareness of conceptual representations of the person and the setting. The importance of a contextual element in processing is very strongly associated with awareness of it. A feature of the setting, for example, is unlikely to have much influence on processing if we have no conscious experience of it. Within the framework this is expected, as both awareness and strength of influence are functions of current activation level.

This is not to say, however, that awareness of a contextual element is a necessary condition for it to influence processing. It is not. An interesting example is the finding that our liking for the person we are looking at is influenced by the size of that person's pupils (Bargh, 1997), an effect that can presumably occur without the need for conscious awareness of pupil size or its significance. An unconscious affective judgment of this sort is likely to have an effect on the way we talk to the person, so this is an example of (typically) unconscious contextual representations influencing linguistic processing. What it means in MCF terms is that the person's current pupil size is represented in perceptual and conceptual modules and activates the affective representation, which in turn influences CS activity and, indirectly, linguistic activity. The key here is the very high resting levels of affective representations, which means that they are easily activated and so can come into play even when the trigger – the perceptual representation of pupil size – is not sufficiently active for consciousness.

2.2 Awareness of goals in bilingual processing

Turning to the elements of inherently internal context, there is probably no direct awareness of goals, in language processing or otherwise, but we can be indirectly aware of them via perceptual proxies, including the sounds of their linguistic expression. Whether such proxies become active enough to cross the consciousness threshold largely depends on how active and how enduringly active the goal representation is. An ordinary goal of communicating successfully will probably not result in anything more than a fleeting awareness of this sort, if there is any awareness at all. It can become more than fleeting in the kinds of cases associated with effort. If the goal of communicating with a person is strongly opposed by bottom-up, outside-in influences – distractions – or by active affective representations such as feelings of boredom, then successful continuation of the communication might require strong involvement by the goal-based self, necessarily involving high activation levels and therefore making a conscious perceptual proxy more likely. Without such circumstances the original goal is unlikely to be more than a background element in the conversation, any (indirect) CS awareness then being of the representations involved in carrying out the goal.

In a more specifically bilingual case, the person might have a (sub-)goal of using a language that the interlocutor is comfortable with, and execution of this goal could be opposed by factors favoring a different language, such as relative difficulty, negative value associated with the intended language, or the presence of other people or other features of the external context. If such opposition does exist, continued use of the intended language might well involve an indirect awareness of the goal.

2.3 Awareness of affect in bilingual processing

In cases like these, awareness of affective representations is likely to feature more prominently than any indirect awareness of goals. If the original goal of using a particular language is highly valued (connected to !pos! with a highly active index), then processing that is consistent with that goal can yield conscious feelings of rightness. More prominently, processing that is inconsistent with the goal – use of the other language – can yield conscious feelings of wrongness. The effect of value in these cases is to maintain the original goal. Alternatively, if a potential distraction or a conflicting goal is especially valued, value can encourage a deviation from the original goal. This influence can extend to the emotions of which value is a component. The feeling of wrongness produced by deviations from the goal could become a sense of guilt or shame. The feeling of rightness resulting from continued use of the intended language in the face of opposing influences could become a sense of pride or satisfaction.

These examples bring out the role of value in monitoring behavior, seen in the feelings of rightness and wrongness. When we stop speaking or alter our speech because something felt wrong, this is negative value, accompanied by awareness, acting as controller. When there is a feeling of production going properly, this is awareness of positive value supporting particular processing, also a form of control. These phenomena are the basis of monitoring, which we will consider in more depth shortly. The same is true in comprehension. Sometimes a feeling of wrongness intrudes in reading or listening, indicating that comprehension is not proceeding in the way it should and thus encouraging changes. A comfortable background sense of comprehension going as it should, on the other hand, is awareness of positive value.

Affective representations are also prominent sources of activation for goals. Fear associated with the idea of making mistakes in a language, for example, can activate a goal of avoiding mistakes, and a variety of subgoals such as simplifying speech, avoiding particular topics, speaking very slowly and carefully, or simply avoiding the language entirely. Conscious experience of the fear implies that the AfS representation is highly active and therefore exerting a significant influence on processing. Especially strong conscious experience implies especially strong influences.

2.4 Awareness of self in bilingual processing

The final element of internal context, self, is relatively straightforward here. Awareness of self is a normal, inevitable part of experience, and as self is a constant controller, this means that we are aware of the controller. The cases in which the role of self in control is most evident are those involving effort, which we addressed in the preceding section.

2.5 Conclusion

Thus, we are often aware of the factors of internal context when they are influencing processing. Saying that we are aware of them is not saying, however, that we are aware of them *as* controllers. Awareness is of representations, not of causal relations between the activity of different representations. When an experienced emotion, for example, is exerting a strong influence on linguistic behavior it is easy to deny this influence and attribute our behavior to more rational factors, or simply to deny the behavior. If fear of making mistakes or embarrassment about a foreign accent inhibits someone from speaking their L2, this is control by an affective representation, but the person can only judge the control by looking at the emotion and the behavior and inferring the presence or absence of a causal link.

3. Consciousness, internal context, and metalinguistic knowledge

In this section we will consider the important topic of metalinguistic knowledge in terms of the MCF treatment of consciousness and internal context. We will look first at the nature of metalinguistic knowledge and then at its general role in bilingual processing. This will be followed by a return to the topic of L3 acquisition, now considered in terms of the role of metalinguistic knowledge and the conscious experiences associated with its use.

3.1 The nature of metalinguistic knowledge

In familiar discussions of the topic, two aspects of metalinguistic knowledge are standard. The first might be called metalinguistic *awareness*. This covers a range of phenomena starting with a general awareness of some aspects of language without any supporting expert knowledge, as when children play with rhymes and puns without really knowing much about what that entails, and ending with awareness that is enhanced by the presence of detailed expert knowledge as displayed by academic linguists and those expert in literary language and style. The term metalinguistic *knowledge* implies the existence of representations that support the latter type of awareness, or rather something on a gradient between completely inexpert and highly expert. For many people, metalinguistic knowledge will be the outcome of their general education which almost always includes the provision of some basic knowledge about the mother tongue. As just implied, much if not in fact all of our metalinguistic knowledge is associated with affective representations allowing us to label given aspects of language as correct or false, or ugly or beautiful and so forth.

Metalinguistic knowledge is in essence conceptual knowledge about language. In MCF terms, this means that any CS representation that constitutes knowledge about language is metalinguistic knowledge. This notion does not always involve consciousness, since a representation of this sort need not have a sufficiently high resting level to allow (indirect) awareness of it. Similarly, knowledge that was originally conscious could lose that status via automatization (see Truscott, 2015a, for an MCF account of automatization).

But for practical purposes the intimate association of awareness with the use of metalinguistic knowledge is nonetheless real and important. It follows simply from the fact that both depend on the current activation levels of the relevant representations. If a given representation of metalinguistic knowledge does not achieve a high enough level to influence conscious experience it is not likely to have a strong influence on processing in general, including linguistic processing. Discussions of metalinguistic knowledge in the literature are about cases in which the level *is* sufficiently high for awareness, a focus that is appropriate given that these are the cases in which it is likely to have a significant impact on processing.

3.2 An MCF analysis of metalinguistic processing

How then does metalinguistic knowledge operate in MCF, and how is its operation related to conscious experience? Normal, fluent language production is a product of processing in the specialized language faculty. The process begins with a message representation in CS, which activates coindexed representations in SS, which in turn activate coindexed PS representations, which then serve as a basis for production. But there is an additional route as well, involving metalinguistic knowledge in CS, and the two routes differ in the involvement of consciousness.

The existence of the alternate route is clear from the fact that we are able to produce non-linguistic sounds, such as an imitation of the wind or of a creaking door. In other words we can go from the concept of wind, in CS, to the motor systems responsible for movement of the lips and the tongue and all the other components of speech. There is no apparent reason why this route would exclude production of sounds based on language-related CS representations, i.e.

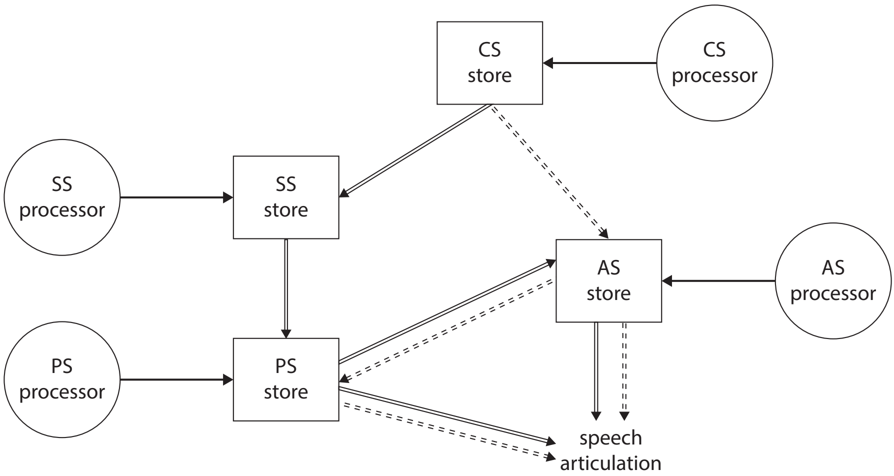

Figure 11.1 Two routes in speech production

metalinguistic knowledge. Figure 11.1 (adapted from Truscott, 2018) shows the two paths as they are naturally treated in the MCF. Solid double arrows connecting the stores represent the CS-SS-PS route while the dashed double arrows show the alternative, CS-AS route.[2]

This latter route can be used to produce a language-like utterance in the absence of any development in the specialist modules, SS and PS. A person who has no experience whatsoever with Mandarin, for example, might read in a book that 'hen hao' means very good and 'laoshi' means teacher, and that a noun phrase can be formed by inserting 'de' between a modifier and a noun. The person could then indicate their favorite teacher and say 'hen hao de laoshi'. It would presumably be done with horrendous pronunciation, which could then be improved by giving the person additional metalinguistic knowledge.

Here we see conceptual knowledge controlling language production, as an alternative to the use of (undeveloped) SS and PS representations. The schemas representing the Mandarin words initially consist of visual representations of the written forms in VS (not shown) and coindexed conceptual representations in CS of the form described in Chapter 5 (3.2). These representations activate sound representations in AS, resulting in articulation of 'hen hao de laoshi'. This very deliberate sort of production is certain to involve a highly active goal representation (the goal of producing the utterance) dominating the goal-based self. As the process would not be carried out in an automatic manner and would require some maintenance of the relevant representations, a sense of effort is likely to be present – a conscious experience that *I* am working to achieve this goal.

2. AS being auditory structure.

Importantly, though, interaction with the specialist system does occur even in this extreme example. The speaker will presumably use existing pronunciation skills, based in PS and AS, to control the articulation. In terms of the framework, looking at the written forms ('hen hao', 'laoshi', and 'de') results in construction of VS representations, which then activate PS and AS representations of sounds from the known language, which then shape the actual articulation.

The interaction of the two routes, for this special case and for production in general, can be seen in Figure 11.1 in the form of two parallel arrows at three points. Articulation, in this case and more generally, is based on both abstract linguistic representations in PS and generic sound representations in AS, which constantly interact regardless of where their initial stimulation came from. Thus, both routes involve the connections between AS and PS and the connections of each to the articulatory mechanisms. The difference is that in the specialist route PS stimulation comes via SS while the non-specialist route bypasses SS, going directly to AS, from which stimulation of PS can then occur. Thus, the two routes are CS-SS-[PS-AS]-articulation and CS-[AS-PS]-articulation, where the brackets indicate that both PS and AS play a role in the final articulation, in each route.

This simple picture provides a means of conceptualizing and studying the way that metalinguistic knowledge influences production. Metalinguistic knowledge is, again, CS representations of information about language. From their CS home they can activate representations in AS and thereby influence the form that an utterance takes. If the specialist route produces the string 'to boldly go', for example, and CS contains a representation of the belief that infinitives should never be split, an alternative AS 'to go boldly' might be constructed as a result of that representation's activity. We then have a competition between the two routes for control of articulation. The winner is determined, as always, by relative current activation level. If the metalinguistic representation in CS is not very active at the moment, then it will have little influence and the product of the specialist route, 'to boldly go', will surface in production. If, on the other hand, it is highly active then it will take control of processing in AS, forcing AS activity to conform to its demands, thus yielding production of 'to go boldly'.

Perhaps the most interesting point here is how the metalinguistic representation could have obtained its very high activation level. Two possibilities exist. One, presumably the typical situation, is that the high current activation level is a product of self-based processing. In this case the speaker is a person who values the use of 'proper' English; in other words !pos! is associated with representations like 'don't split infinitives'. The natural consequence is that a goal of using this representation is established in CS and can sometimes dominate the goal-based self. When it does, it thereby gives the 'don't split infinitives' representation a very high current level. It will then exert a very strong influence on processing in AS, resulting in the production of 'to go boldly'. This self-based processing is naturally accompanied by a conscious sense of effort and of volition ("I am avoiding the split infinitive"). There should also be awareness of both of the possible utterances, as the automatic specialist route leads quickly to construction of 'to boldly go' in AS and this representation is then replaced, in a slower, non-automatic fashion, by the 'to go boldly' representation.

The other possible source for the high activation level of a metalinguistic representation is somewhat more speculative and raises interesting issues. On this view, the representation has been used extensively in previous processing and so has a high *resting* level. In this case it can quickly and easily reach a high current level, with only limited stimulation. This is automatic processing – automatization of metalinguistic knowledge. In this case there might be little or even no awareness of the 'to boldly go' representation that is being constructed by the specialist system; this representation will have little or no opportunity to appear in AS – the only place where it can reach activation levels sufficient for awareness – because when it is formed its metalinguistically preferred rival promptly (automatically) replaces it there. The conscious experience then can, in the extreme case, lack any sense that the metalinguistically based form is replacing another possible form, or that the alternative form was ever present.

Whether this theoretical possibility is realized in practice is a question that we will leave open. If significant automatization in a case like this is possible, the question also arises of how extensive this process can be and the effect it has on fluent, accurate production. To what extent and in what ways might automatized metalinguistic knowledge supplement or replace the use of the specialist CS-SS-PS route? What general effects would this have on the overall functioning and development of the specialist route, with what consequences for performance? If it is accepted that automatized metalinguistic knowledge can supplement or substitute for use of the linguistic modules, we must also acknowledge the possibility that it can also interfere with their proper development and use, with unclear but potentially serious implications for performance. These are large issues that we will not try to address here. The point to be made is that casting the issues in terms of a broad framework like the MCF can raise interesting questions, help to clarify issues, and point to ways of studying them.

3.3 Metalinguistic knowledge and L3 acquisition

In Chapter 9 (Section 4) we considered the topic of L3 acquisition, focusing on the question of which of the multilingual's other languages most influences the L3, and why. Consciousness and metalinguistic knowledge are intimately involved in this issue, so we will continue the discussion here.

In the previous discussion we described the idea that typological similarity can help determine the relation of the other languages to the L3. This could mean actual similarity between languages, as was assumed there, or the person's *perception* of similarity. This 'psychotypological' view of the L3 in relation to other languages is intimately associated with awareness and metalinguistic knowledge, as it is likely to be formed through reflection and analysis on the basis of knowledge formulated in the code used in the conceptual system like any other kind of metacognitive knowledge.[3] It might be, then, that individual bilinguals think that the grammar (syntax and phonology) of their L3 bears a closer resemblance to their L2, say. This opinion should show a substantial influence on their grammatical behavior in L3 only when it is directed consciously as, for example, when they self-correct to make their spoken or written L3 performance more L2-like or when they are asked to judge the correctness of L3 sentences in a grammaticality judgement task, especially when that task allows them some time for reflection.

Structures in SS and PS are qualitatively different from metalinguistically related representations such as the conceptual structures SYLLABLE, PREPOSITION, and ADJECTIVE that form the independently created conceptually-based grammar.[4] However, semantic and pragmatic representations are another matter since they, unlike PS and SS, are formed in the conceptual system. The contents of any conceptual representation can, in principle, be projected into consciousness depending on whether its activation happens to be in a state that allows it to be raised high enough to achieve the appropriate 'breakthrough' level. Although the acquisition of semantic and pragmatic knowledge does not absolutely require it, this clearly opens up the possibility that conscious metalinguistic processes can also play a role in shaping an individual's semantic and pragmatic knowledge of their L1, L2, L3 and any other language that they are able to use. By no means all semantic and pragmatic knowledge will be based on conceptual representations that happen to have a high enough activation level to participate in conscious reflection. Still, where it does, becoming aware of, or having the belief about the existence of many lexical similarities between L1 and L3 (as opposed to L2 and L3)

3. Psychotypology is a term coined by Kellerman (1986) to differentiate the informal impression of those who are not expert from an academic linguist's typological analyses and their expert assessment of formal relatedness between particular languages.

4. The SS prep, for example, is not directly associated with the concept (CS) PREPOSITION: New metagrammatical knowledge about the syntactic behavior of prepositions encoded as CS will not automatically result in parallel changes within the core language system. There may indeed be glaring discrepancies in bilinguals' consciously held beliefs about how prepositions work in L2 and L3 (or indeed L1) and the way the SS prep and its various associations influence their grammatical performance in those languages.

may well lead to an increase in likelihood of L1-based non-native lexical creations in L3 where the learner/bilingual has not yet been exposed to the existing L3 word in question (Kellerman, 1979).

Beliefs about relationships between two languages may also influence the use of words and expressions so that the language user's translation equivalent in L3 of an L1 word like 'dinner' will be assumed to be identical in meaning in every respect including its pragmatic meaning. It will also be the case that pragmatics of particular syntactic constructions may also be affected in the same way. It is one thing to know the syntax of subject pronouns for example, i.e. the fact that they can be either included or omitted, but the question of where exactly they can be omitted requires contextually-based knowledge (Belletti, Bennati, & Sorace, 2007). This implicates the conceptual system and hence opens the possibility of metalinguistic influence. In other words, newly acquired metalexical knowledge and metagrammatical knowledge may influence meaning and usage, i.e. anything that has been formed in the conceptual system.

This has clear implications for explicit instruction in these particular areas of language. But more importantly from a theoretical perspective, evidence of such metalinguistic influence elicited experimentally cannot be used to make assumptions about internal phonological and syntactic relationships. The syntactic behavior of prepositions or subject pronouns that has nothing to do with their meaning is another matter.

4. Consciousness in translation and interpreting

Translating and interpreting involves skills that are not much developed in bilinguals without specific training, which means in effect that being bilingual does not necessarily mean being a good translator. Conscious processes play a crucial role in these skills.

4.1 Translation and interpreting

Translation as opposed to interpreting, a special type of translation activity, normally entails working with written text; especially where there is no time pressure, translation is an activity which is easier to manage or learn to manage simply because it involves switching from one language to another and back in a manner controlled entirely by the translator: The original source text is available for inspection all the time as the target text is being created (see also Sharwood Smith & Truscott, 2014b, pp. 207–209). This allows relatively more time for conscious processes to mediate between the two language modes although professional translators working under great time pressure do not have this luxury making their mode of working closer to that of interpreters. In this process, then, metacognitive processing plays a crucial role in consciously engineering the switching to and fro between one linguistic system and the other. That said, subconscious processing nevertheless plays a huge role. 'Deliberate' language switching is only deliberate to a limited extent. Consciously planned events rely on the triggering of a host of subconscious processes for the planned switches to occur in the first place.

Translation offers an excellent picture of the role and limits of conscious processing in general. Translators have, in a series of back-and-forth language switches, to, so to speak, 'think themselves into' the other language. For example, if going from an L1 mode into an L2 mode, the translator has to try and focus on the meaning of the source text and away from its realization in the L1 while at the same time summoning up relevant L2 contexts and in this way allowing the L2 to temporarily take over. Although the impression may well be that this whole process is conscious, a few moments reflection should correct that idea. Translators effectively have to wait for fragments of the target language to appear in their minds in response to their conscious bidding without any sense of the processing that underlies the appearance, in the same way that mental arithmetic takes place where numbers rather than words magically appear in the individual's conscious mind.

Consecutive interpreting where, in successive turns, a short stretch of the source utterance is interrupted by a pause to allow the interpreter to produce an immediate translation, is normally done in a speech mode and therefore imposes more strain on working memory as the input source once produced becomes unavailable and so has to be committed to memory. In other words, the interpreter needs to keep in mind the spoken fragment of oral discourse that has just been uttered in the current source language in order to produce, immediately afterwards, a translation in the target language after which the whole process is re-enacted in reverse with source becoming target and vice-versa. This means that, at each turn, the relevant representations of the source and target utterance fragments have to be held in working memory simultaneously (i.e., kept highly activated) allowing rapid shifts between the two until a satisfactory translation has been achieved.

4.2 Translation and interpreting in the MCF

In terms of the framework, the translation process can be seen as an interplay of self-based and selfless processing, with the implications for conscious experience discussed above. Consider first an ideal, trouble-free case. The process begins with the L1 input (the text to be translated) activating the language schemas needed for comprehension of that input. This is likely to involve awareness of the perceptual components of those schemas – POpS representations of the written words and possibly a 'voice in the head' auditory version. The subsequent use of these perceptual representations is simply the modules doing their work in a largely automatic manner – it is selfless processing and is, setting aside the input representations, unconscious. In CS, the outcome of this processing is a representation constituting the message expressed by the input. In the ideal, trouble-free case, this representation then activates L2 representations in SS, a process that ends in the production of an L2 string expressing that message. Awareness will be of the spoken form of this string and then of its written form as the translator writes it down.

This neat picture is of course too good to be true as a general picture of translation. First, and least interestingly, the process might be disrupted by a distraction, from external events or from thoughts. More interestingly, contrasts between languages and cultures might well dictate adjustments in the message representation, compromises between exactly what is to be expressed and the means offered by the L2 to express it. Contextual components of the message are especially likely to be troublesome. Closely related is the possibility that the L2 representations that are most appropriate for the message will not be readily available due to lower resting levels than those of less appropriate rivals.

If any such issues arise, the task of translating will require that the L1-related schemas be maintained in an active state ('in working memory') longer than would normally be the case – longer than they would be as part of ordinary, automatic processing. This requires that a goal, the goal of maintaining the information, be continuously active, and perhaps highly active. This goal activity will sometimes be a largely automatic consequence of activity in the overall goal of carrying out the translation task, automatized by extensive past experience;[5] this is an assumption underlying the trouble-free case above. But any problems in the direct input–message-output sequence could cancel this automatic processing. Continuing activation of the schemas is then likely to require involvement of the self; in other words the processing becomes deliberate, self-based processing. As described in the previous chapter, this self involvement gradually raises the activation level of the !effort! representation in AfS, yielding a conscious experience of the effort involved in carrying out the currently dominant goal (i.e., holding on to the input).

Extended involvement of self, with the resulting experience of goal-directed effort, can also occur in regard to the L2 production component of the translation task. If the immediately available L2 schemas are not appropriate, the automatic processes of the linguistic modules will be disrupted by demands from CS. These demands come from the goal of expressing the original L1 message, or perhaps from a subgoal of finding a particular word or phrase that expresses a particular

5. For an extended MCF account of automatization, see Truscott (2015a).

part of it. If this goal is to remain active for a time, involvement of the self will ultimately be needed, resulting in a conscious experience of effort in achieving that goal. The process is likely to also include a conscious sense of wrongness (activation of !neg!) when a problem occurs and of rightness (activation of !pos!) when it is resolved.[6]

The interpreting process, understood within the MCF, should involve largely the same processes as translation, with the difficulties accentuated because of the time pressures. If there is a need for L1 schemas to be held in an active state for any length of time due to the kinds of issues described above, new input received during that time might not be adequately processed. If instead the new input replaces the old, the ongoing L2 production is likely to suffer, as it has to be completed before the L1 input has been adequately processed. In translation of written texts, schemas that are not being used at the moment can be allowed to fall considerably in activation level and then be reactivated later, simply by means of a second look at the written text. In the case of interpreting no second look is possible and so the schemas needed for the task cannot be brought back once their current activation level has fallen very substantially. A further problem for interpreters is that under the time pressures that they face, the various goals and subgoals involved in the task can easily interfere with one another.

5. Conclusion

In this chapter we have considered the implications of our account of internal context for an understanding of the conscious experiences accompanying bilingual processing, and the absence of such experiences. This includes the variable awareness of the different elements of internal context and the way such awareness is related to metalinguistic processing and translation and interpreting. Some of the proposals are necessarily tentative and of course somewhat sketchy. The point is that the MCF allows us to place familiar impressionistic descriptions, of translation and interpreting processes for example, into a much more formal perspective allowing a theoretical analysis of the complexities involved. This theoretical analysis should in turn assist the design of experiments and the interpretation of the findings.

6. Interestingly, an MCF account of (monolingual) editing would have a great deal in common with this account of translating, a topic we will save for another time.

CHAPTER 12

Conclusion

1. The mind and its role as generator of internal context

We will now conclude, starting with the model of mind being used and continuing with a review of the main themes that have been dealt with in this book and finishing with some final reflections. The internal context of bilingual processing is necessarily understood within a particular understanding of the mind as a whole. This understanding is provided by the MCF.

1.1 The mind

The model of the mind that this framework provides is by its very nature always work in progress. It can however be treated as a basic 'working' model that is our best guess to date on how the mind works and particularly how it accommodates more than one language. It is based on a reading of the cognitive science literature within and beyond the scope covered by linguistics. How the individual processors work with the items that are currently activated in their memory stores is a question for researchers in the domain that is relevant to the system in question.

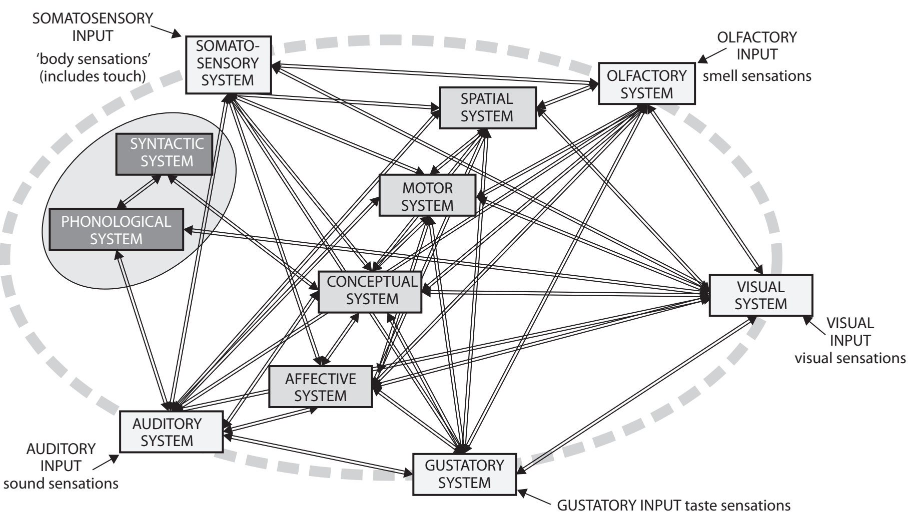

Figure 12.1 The MCF mind: The generator of internal context

As will hopefully have become very clear by now, the immediate contribution of such a framework is to supply coherence and precision to important aspects of research that have been left vague or even unspecified like the nature of memory and the role of consciousness and how specifically language representations are integrated into cognition in general. If new explanations and hypotheses emerge as a result of trying to integrate existing research done within specific areas in the modular cognition framework, so much the better.

In the course of the book, some parts of this cognitive system have received special attention. Firstly, the core language system, which we have defined broadly following Jackendoff, as consisting of a syntactic and a phonological system, the 'linguistic' modules not to be confused with the modules implicated in language as a whole which cover most if not all of the system displayed in Figure 12.1. From the point of view of bilingual processing, two aspects are especially important. In the first place, the core language system is not differentiated according to which language is being processed. There is no tagging system in PS or SS to mark which of a bilingual's languages is being processed. In the second place, core linguistic processing proceeds efficiently with relatively low activation levels. This explains why the contents of SS and PS never participate in conscious experience. The two grammars, each anchored in a different module, can be regarded as separate with only the contents of conceptually based grammar capable of participating in conscious experience or at least the content of those representations that have the requisite activation levels.

The second system that has received special attention is the conceptual module. This is a system that is enormously complex as developed in humans although it seems reasonable to attribute much reduced versions to other species higher up on the evolutionary ladder. It plays a central role in processing, acting as a hub for the many schemas that become active during language activity. It typically operates in conjunction with the (also highly important) affective system where emotion and value are processed.

Self, one of the key aspects of MCF, and of internal context, has received considerable attention here, but it does not have a place in a picture like that of Figure 12.1. This is because it is best seen as a schema, composed of three types of selves that interact with one another. The *goal-based self* and the *meta-self* are found in CS and the *affective self* in AfS.

1.2 The mind as generator of internal context

As far as the main focus of this book is concerned, the mind should also be seen as the generator of internal context, the sum total, on a given occasion, of all current processing activity along with its informational content that accompanies and impacts on linguistic processing. This arises as an interaction between, on the one hand the current activity originating in the environment, or 'situational context' and, on the other, the inherently-internal source, i.e. the mind as depicted in Figure 12.1, a cognitive system responsible for creating, storing and processing representations.

In any given situation, an individual's current processing activity – the internal context – represents the complex operations of the modular mind summarized in Figure 12.1. Each of the eleven systems displayed consists of a dedicated processor and store. Currently activated representations (providing the internal context) are what constitute working memory on a given occasion, or, to be precise, a particular combination of current working memories in each store. Representations are co-activated in the form of schemas via a system of interfaces that connect up stores (represented by double bi-directional arrows in the figure). Representations that are very highly activated participate in conscious experience. All this activity makes up the internal context of bilingual processing, including both comprehension and production.

2. Elements of internal context

We began the book by making a basic distinction between the outside-in context and the inherently internal context, the latter being the central concern of the MCF. While this is not an entirely exhaustive or entirely clear-cut distinction, it has proven valuable in explicating the nature and influence of internal context.

2.1 Outside-in context

In any given processing event, the bilingual like any other individual is faced with a tsunami of sensory stimuli which we as outside observers know to be a given 'situation.' This general external context in which bilinguals acquire and use languages is crucial and not surprisingly has been extensively researched from a sociolinguistic and anthropological perspective. It has also been developed here in terms of the way it is represented in the mind of the bilingual, in Chapter 5, and has played an important role throughout the book. The way these sensory stimuli are processed by language users to create an interpretation of their experience might be seen as an 'internalization' of outside events. In fact, 'outside-in context' processing results in cognitive activity that is composed entirely from elements that are already present. Put crudely, nothing from the outside environment actually goes in. Every aspect of the internal world of the language user, bilingual or otherwise, is internally generated.

2.2 Goals

Despite the fact that they enter into many discussions of language development and language performance, goals tend not to be defined in precise psycholinguistic terms. They are nonetheless extremely important for bilingual processing since so much of bilingual behavior (as most other aspects of human behaviour) is in the service of goals. It is therefore necessary that a framework such as the MCF defines what they are and how they work. A goal structure is a composite structure located in the conceptual module. It represents a valued but unrealized state and the intention to seek it. The seek intention is captured by the CS *SEEK*. Further precision about how goals operate may be added once a particular theory of goals is applied to extend what is supplied by the MCF.

Goals are recognizable from the characterization of a conceptual structure that is activated during goal-directed behavior. Recall this is not about the conceptual structure GOAL: This is simply the meaning that would be associated with words such as 'ilakku' in Tamil or 'cel' in Polish or indeed 'goal' in English. CS GOAL is not part of the definition of goals in the sense in which we have been using the term throughout this book even though goal-based structures are themselves written in conceptual code: When a particular composite CS representation has a particular form, as described in Chapter 4 (see Figure 4.1), we call it a goal. It may contain a main goal plus many subgoals. New goals are routinely created during the life time. CS primitives will also be involved, *SEEK* being an obvious candidate. The significance of goals as internal context of bilingual processing lies in their influence on construction of the message representation in CS and therefore on processing in SS and PS.

2.3 The goal-based self

We defined three types of self, interacting with one another. The one that received the most attention was the *goal-based self*, which is based on physical and social needs and organized around the CS *SEEK*. It is thus a highly composite representation consisting of a very large number of goal representations. As such, part of its role is to make goal-based behavior relatively coherent and consistent. It also serves to focus and strengthen goal-based processing: If a goal representation is active and dominates the goal-based self representation (as depicted in Figure 8.1), then the self will exert a strong influence towards the achievement of that goal, influence of course being defined in the MCF in terms of effects on current activation levels. In this case the goal is the person's intention of the moment. The goal-based self is thus the source of volitional thought and behavior, including for example a deliberate decision by a bilingual to use one or the other of his/her languages.

2.4 The meta-self

The second type of self found in CS is the *meta-self*, described as the personal theory of oneself. It is built around the ME concept (which is probably a CS primitive); that is to say the meta-self is a highly composite representation consisting of ME and a great many representations constituting characterizations of me. It includes, possibly as coherent units, the *possible selves* that have been hypothesized in the literature, such as the *ideal self* and the *ought-to self*. A bilingual may have more than one (presumably overlapping) meta-self, possibly including one associated with each language. Where factual information in CS gets combined with the ME concept we have the basis for 'semantic autobiographical' memory, which consequently becomes part of the meta-self. This type of self is also important as a source of goals, including those that can be crucial for second language learning.

2.5 Affect: Value, emotion, and the affective self

We have devoted considerably less attention to the affective elements of internal context, because their influence on bilingual processing is more indirect, operating primarily by way of CS, which has been our focus. Their significance is beyond question, though, and it is worthy of much more extensive development in the future.

We considered three types of representations found in affective structures: value, emotion, and the affective self, the last being a relatively coherent and relatively stable composite of other affective representations; it can be highly active and therefore conscious. One interesting aspect of the affective self is its involvement in memory: Episodic memory consists primarily of perceptual representations connected directly to the affective self in AfS, which serves as experiencer.

Although there are no direct connections between AfS and the linguistic modules (see Figure 12.1), indirect connections are quite important. The indirect influence of these affective elements on bilingual processing appears in three forms. First, through their connections to CS representations they directly influence the activation levels of those that can potentially participate in the message representation that is under construction; they thereby help to shape the message, in both comprehension and, especially, production. Second, their CS connections include goals and their components, allowing them to influence the activation levels of these representations, with important effects – a goal that is highly valued in the current context will for that reason be more highly activated and exert a greater influence on bilingual processing. A third form of indirect influence was more briefly considered, specifically involving the affective self. Its intimate association with the goal-based self means that its activity can greatly affect the involvement or non-involvement of the latter in ongoing bilingual processing.

3. Control

Control (cognitive control), primarily associated with the prefrontal cortex, was important enough to occupy three entire chapters. Control has no generally accepted definition and, in the MCF, is an aspect of internal context, a matter of selective activation of representations resulting from activity of a variety of already-active representations. In fact, the term 'control,' like the other popular terms, 'access' and 'selection', wrongly suggests the existence of a supervisory agent: In MCF a language is selected because certain representations are winning the competition, not because some intelligence has chosen them. A better way of describing control is 'influences' coming from a variety of sources, in other words from internal context.

For this reason we prefer to avoid these terms and have followed a line of thinking that sees the mind as certainly containing local hierarchical systems but seen from a wider perspective as heterarchical: No single part of it can be identified as a central executive system. Our outside-in experience is dynamic, constantly changing and never completely repetitive in every detail; our inherently internal resources have to have a high level of flexibility to respond to this. This suggests, then, that an otherwise fixed modular architecture has to allow interaction between systems to operate in such a way without a predetermined, fixed order whereby one system dictates what all the others do.

In bilingual language performance, a bilingual individual's change of location such as going from home to school, can cause a cascade of other changes. It may be the result of goal-directed behavior for reasons entirely unconnected with which language is to be used, for example. Nonetheless it can trigger processing activity that shifts the balance between the current language being used and another, currently unused language. The same thing happens with unforeseen encounters with language users who do not have exactly the same set of languages at their disposal. An interaction is engaged between the outside-in context and the inherently internal context. Activated representations in the conceptual system automatically lead to a triggering of coindexed structures in SS and this in turn stimulates activity in PS. SS and PS representations will each have their own different resting levels which will also influence their availability for processing.

It might look as if CS representations are controlling what happens elsewhere but we need to keep in mind the fact that the processor within each other module, e.g. SS and PS, will put together representations consistent with its own unique internal principles. Also, representations in the conceptual system are subject to outside-in influence as well as influence by value and emotion coming from the affective system. These last two influences on CS representations will amplify some associated linguistic representations relative to others privileging, at that point, one language over another. It should also be remembered that CS itself is by no means a monolithic actor. A great many different representations there are interacting and competing for influence over processing in SS and PS. Control is seen therefore not as a thing in itself but as derivative and typically heterarchical thereby avoiding the danger of falling into the homunculus trap. Bilingual processing thus offers good examples of how control and its source(s) should and should not be conceptualized.

Finally, we have tried to stress the fact all along that a theory of control should follow from an understanding of the general nature of representation and processing. That (provisional) understanding comes in this case from the MCF. The notion of internal context that we have developed here to account for control, including bilingual language control, is essentially a spelling out of the implications of the general understanding offered by the framework. This demonstrates a key principle motivating the MOGUL project which is, namely, that language, and in this case bilingual processing, must be studied in the context of how the mind as a whole operates, hence the need for a sufficiently elaborated 'mind-wide' framework like the MCF for conducting such research.

4. Some implications and applications

A broad framework like the one we have offered naturally has implications for a variety of topics. Exploration of some of these topics was the business of the three final chapters.

4.1 Internal context and interlingual coactivation

Much of the research in bilingual processing can be seen as centered on phenomena of coactivation – during any instance of processing, representations from both of the bilingual's languages are likely to be active. In Chapter 9 we looked at some of these phenomena, casting them in terms of internal context and the MCF. Topics included the idea of 'non-selective access', the factors behind which language influences which in processing, optionality in second language acquisition, and code-switching. These are rich areas of research, and we did not attempt anything like a thorough discussion, focusing instead on some of the most directly relevant points and considering some possible implications of our approach for future research.

4.2 Internal context and attention, working memory, effort, and consciousness

Our MCF-based account of internal context has much to say about some key cognitive concepts and their relation to bilingual processing, and this was the topic of Chapters 10 and 11. The discussion was in line with our constant concern with unity and parsimony in development of the MCF: Explanations of individual phenomena and aspects of the cognitive system should be as much as possible a spelling out of the implications of representation and processing within the MCF architecture. This describes especially the way we have approached attention and working memory. For consciousness we add the simple, independently motivated principle that a representation becomes the object of awareness if and only if its current activation level is sufficiently high. The account of effort involves little more than the very natural addition of an !effort! representation in affective structures. And throughout we have sought to avoid the constant danger in this area of relying on a homunculus to explain apparently intelligent behavior in the system.

5. Final reflections

It may be tempting to the think of the framework that we have used over the last eighteen years in the MOGUL project as a theory of bilingual processing. We have often stressed that this is not the way of seeing it. We make a sharp distinction been theories and theoretical frameworks. However, it is true that to talk about the framework and, in our discussions, make specific reference to aspects of language acquisition and language processing in bilinguals, we have, effectively, *implemented* some of the framework and thereby made theoretical claims which can be investigated further. Nonetheless the framework itself integrates features of many theories taken from different corners of cognitive science for which we cannot claim any originality.

One of the theoretical commitments we have gladly made, by accepting the force of language learnability arguments, is that any account of the human mind must involve a domain-specific system for acquiring language. We appreciate attempts to frame (slightly) more parsimonious accounts that exclude anything resembling a language 'faculty' but are not impressed enough that they have been able to account for syntactic and phonological ability: It seems to us that we will have to wait a very long time for this to happen. We would no more deny the plausibility of human language being special in this sense than we would if we were talking about a special biologically endowed ability to account for the behavior of songbirds, although we acknowledge the evolutionary debate still rages around the issue of how human language came about. It is worth pointing out in this context how much of the MCF account of language, and with it bilingual processing, involves systems *outside* the core language system itself. In this respect much research done by those who work only with general cognition and no language faculty is still very relevant for us.

Another commitment which will have become abundantly clear in the course of the last half of the book is the characterization of the mind, and therefore bilingual processing, as basically heterarchical. That being so makes it all the more important to view separate theories such as code-switching, cognitive control etc. within a larger perspective. By doing so, using the MCF, we have concluded that the phenomena under investigation cannot be properly accounted for without applying principles that hold across the modular architecture that dictate how different cognitive systems interact and, of course, keeping in mind the unique principles that hold within each collaborating module. A much more concise way of putting this is to say all explanations have to be framed in terms of the internal context.

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General index

Name index

This book offers a broad-based account of bilingual processing, drawing on research findings and current thinking from various domains across cognitive science. The theoretical approach adopted is the Modular Cognition Framework in which language processing is characterized as an interaction between dedicated linguistic systems and the other modules of the human mind. The latter provide the 'internal context' of bilingual processing. This internal context involves goals, value, emotion, self, and representations of the external context. The book combines all these elements into a coherent picture of the bilingual's internal context and the way it shapes processing. It then shows how some central concepts in cognitive science and bilingualism fit in with – and follow from – this view. These concepts include working memory, consciousness, attention, effort, codeswitching, and the possible cognitive benefits of being bilingual. The book should be of interest to professionals in the field as well as postgraduate students and advanced undergraduates.

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