An Interactive Approach to Enhancing Early Word Learning

From Research to Best Practice

Lakshmi Gogate

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INTRODUCTION

PRESSING ISSUES IN EARLY WORD LEARNING

The benefits of providing an optimal environment for language learning from which infants and young children can glean the properties of their native language are manifold. The general consensus among language researchers and speech-language pathologists on facilitating language development is that exposing the young infant to an optimal socially-interactive language environment enables the typically developing child to actively participate in it and learn a language, its sounds, words and their meaning, its grammar, and appropriate ways to use it to communicate in context (Hart & Risley, 1995; Huttenlocher, 1998; Zimmerman, Gilkerson, Richards, Christakis, Xu, Gray & Yapanel, 2009; Hassinger-Das, Bustamante, Hirsh-Pasek & Golinkoff, 2018). This is because language development, including vocabulary development, results from an ongoing interaction between the language environment and the infant (Gogate & Hollich, 2010; Samuelson & McMurray, 2016; Smith, 2005). Consequently, several sources of converging evidence illustrate that depriving the child of this language environment is detrimental to achieving a developmentally appropriate vocabulary, posing long-term negative consequences for later language and school readiness. Early vocabulary is a robust predictor of kindergarten readiness (Friend, Smolak, Liu, Poulin-Dubois, & Zesiger, 2018). Not having a developmentally appropriate vocabulary has cascading detrimental effects on children's grammar and language use during toddlerhood and during the preschool years, as well as reading skills development at grade-level (Kamil & Hiebert, 2005) and general academic success (Hoff, 2013).

The language environment provided by primary caregivers and child language development are closely associated with one another. As a classic example of this association, Hart and Risley (1995) followed-up infants from year 1 to 3 along with their primary caregivers by recording their at-home interactions. The authors found that enriched everyday parental input, both a variety of words and words used more often, to 9- to 36-month-olds is critical for them to achieve an age-appropriate receptive and an expressive vocabulary as well as achieve later language milestones. As another

example, Tamis-LeMonda, Bornstein, and Baumwell (2001) showed that maternal responsiveness during everyday interaction with 9- to 21-month-old infants predicted the timing of their achievement of language milestones. Similarly, Zimmerman et al. (2009) have shown that parent-infant active two-way interaction predicts healthy language development in children. These and other more recent studies (e.g., Golinkoff, Can, Soderstrom, & Hirsh-Pasek, 2015; Weisleder & Fernald, 2013) suggest general guidelines for talking with infants, and establish the critical role of both the quality and quantity of caregiver language-input and interaction in facilitating early vocabulary development.

When clinicians and parents look beyond this general consensus on the benefits of parental everyday interactions using a variety of words in greater frequency, or the general guidelines for talking with infants to facilitate infants' communicative development, however, the picture on exactly how to go about interacting and enhancing vocabulary development in infants and toddlers is less clear. Consequently, parents and early child care professionals are left with the daunting task of digging deeper into the complex body of scientific research for specific strategies that parents and other caregivers can use to enhance infants' vocabulary. Since parents and professionals play a pivotal role in children's vocabulary learning, making them aware of what they can do to facilitate vocabulary learning in the child is a critical component in paving the way to children's word-learning success. Increasing parental awareness about their child's development has been known to increase developmental and language outcomes in children (Rowe, 2008; also Suskind et al., 2016). The primary purpose of the present book, therefore, is to make the early word learning process as transparent as possible for parents and non-research professionals using the classic as well as most recent evidence at hand.

A wealth of research findings in child language learning have revealed invaluable insights into how early language develops. Much of this body of work, motivated in part by the pioneering work of researchers (e.g., Hart & Risley, 1995), has unearthed novel strategies that parents and interventionists could utilize to enhance word learning long prior to infants beginning to produce their first words. These developmentally-appropriate strategies, however, are published in highly technical scientific journals by expert researchers (e.g., Hirsh-Pasek, Alper, & Golinkoff, 2018), rendering them largely inaccessible and incomprehensible to the lay public. If made available in a format accessible to the lay public, these strategies, with further norming[1], could prove to be instrumental in facilitating infants'

[1]Although the empirical findings reported in the present volume are normative, statistically significant findings, they may not have been tested using large data-sets

learning to communicate age-appropriately and could pave a solid path to preschool language readiness. After all, if developmentally appropriate strategies can be utilized prior to language production when infants are highly receptive to these environmental cues, both parents and caregivers might essentially alleviate the potential risk for language delay in their infants and toddlers, thereby reducing the need for language intervention at later ages (Gogate & Hollich, 2013; also Conti-Ramsden & Durkin, 2012). For parents and caregivers to easily access the wealth of research on enhancing infants' word learning, this volume aims to present and interpret the research findings in a user-friendly manner. My goal here, therefore, is to make the research on word learning more accessible for both parents and professionals who are not language development researchers.

Additionally, over the past decade, dedicated attempts to enhance preschool readiness in children have emerged in the form of clinical language interventions that parents (or professionals or both) can provide to enhance infants' language capabilities (e.g., Dunst, Raab, & Trivette, 2012, see www.earlyliteracylearning.org; Mendelsohn, Huberman, Berkule, Brockmeyer, Morrow et al., 2011; Roberts & Kaiser, 2011; 2015). Some of these intervention studies have found significant links between cherry picked early infant abilities (e.g., infants' ability to follow mothers' eye-gaze or share attention), or maternal interaction/language behaviors (e.g., overall maternal word counts, or the duration of daily activities such as picture book reading or toy play) and later child-language milestones (e.g., Brockmeyer Cates et al., 2012; Hassinger-Das et al., 2016). Such intervention studies, although highly informative in their own right, draw little attention to the complex bigger picture encompassing the multitude of factors that contribute to early language development (Cartmill, 2016; D'souza, D'souza, & Karmilloff-Smith, 2017; Gogate & Maganti, 2016; Yurovsky & Frank, 2017). Neither do they draw attention to recent discoveries in early word learning, a requisite for vocabulary building and preschool language readiness that will be elucidated in the subsequent chapters of this volume. Consequently, what has been noted is an overall informational gap between basic sciences research on early language and clinical intervention research on language enhancement (Hassinger-Das, Toub, Hirsh-Pasek, & Golinkoff, 2017). In particular, the results reveal a gap in findings on early language and the optimal age at which intervention is administered (Conti-Ramsden & Durkin, 2012). Language interventions need to adopt an embodied approach and optimize vocabulary learning by tying intervention to scientific findings on young learners' motoric and

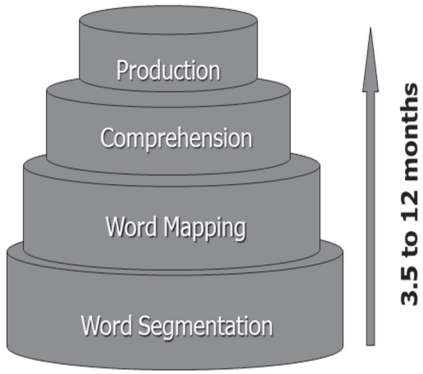
in clinical studies by using a given strategy in an intervention group while not using the same strategy in a control group.

sensory experiences (Hald, Nooijer, van Gog, & Bekkering, 2016). Researchers of language intervention have long since recognized the critical value of integrating "research into the mechanisms of vocabulary learning, [and] translational research that produces effective, feasible early-education practices in homes and schools" to improve children's outcomes and "the nation's wellbeing" (Hindman, Wasik, & Snell, 2016). The present monograph, therefore, also aims to bridge this informational gap between basic research on infants and their caregivers and language intervention studies to encourage further early intervention research.

The primary question that the present monograph aims to address in a comprehensive manner, in the following eight chapters, is what it takes for infants to learn words, starting with the very beginning. Some of the very first words that infants learn in any given language are concrete nouns and verbs that refer to tangible objects or actions, which infants can perceive and act upon easily. Learning about a word, learning what it means, and being able to say a word involve four essential steps, with each step emerging prior to and serving as a building block or a foundation for the next higher step in the rungs shown below (Figure 0-1).

To learn a word, infants must first learn to segment the word from an adult's continuous, albeit highly simplified, stream of speech. For example, when a caregiver playing with her infant using a toy car says- "Look at the car! Nice blue car! Want to play with the car?"- the infant must first learn to segment the word "car" as a distinct unit of speech, or separate it from the remaining continuous speech stream. This ability is observed as early as within the first 4 months of life. How can caregivers enhance this ability? Chapters 1-4 provide insights from scientific research into how young infants learn to attend to and segment words from the ongoing continuous stream of adults' speech using cues from different senses including hearing (Mandel, Jusczyk, & Pisoni, 1995; Bortfeld et al., 2005), vision (Hollich, Newman, & Jusczyk, 2005) and touch (Seidl et al., 2015; http://youtu.be /NfCj5ipatyE). These chapters also illustrate how caregivers can facilitate infants' ability to segment words, once again, using the scientific research on this topic.

Figure 0-1: Four steps to word learning



Next, infants must learn to pair the segmented word with an appropriate object (or action) among many possible referents on the scene, called word-mapping, prior to understanding what the word stands for or means. For example, given the earlier example of continuous adult speech, the infant must learn that the word "car" goes with the blue object with four wheels among several other potential objects on the scene. The ability to map words to objects is observed in infants as early as 3 months (Friedrich, & Friederici, 2017), long prior to infants producing their first word. What are some of the first words that infants pair with objects or actions? How can caregivers enhance infants' learning of novel word-object or –action pairings? Chapters 1-6 suggest several strategies that primary caregivers naturally utilize to facilitate this ability in infants. If these strategies can be taught to other caregivers (e.g., early intervention teachers) it might empower them with the means and methods to enhance this important step in infants' word learning.

The two prerequisite abilities, discussed thus far, word segmentation and word mapping, pave the way for the two latter steps in word learning - understanding what words mean or word comprehension (e.g., Golinkoff & Hirsh-Pasek, 2008; Hart, Newell & Olsen, 2003; Maouene, Hidaka, & Smith, 2008; Tardif et al., 2008), and eventually, the ability to produce words. Chapters 1 to 6 provide multiple strategies for enhancing the first three steps in word learning, namely from attention to words to word mapping and word comprehension, once again, using the available scientific

research. They explain why some words relative to others are easier for infants to attend to and understand. In these chapters, wherever possible, I will relate the process of word comprehension to word production, the fourth step to word learning. Finally, whereas the first six chapters focus on monolinguals learning a single language, in Chapter 7, I discuss the special case of bilingual infants to highlight any differences as well as similarities in their word learning relative to that of monolingual infants. Relatively little is known about how bilingual infants learn a vocabulary especially in their first two years of life. Furthermore, in Chapter 8, I will discuss cultural variations in word learning, focusing on infants' learning of nouns versus verbs across cultures learning noun-friendly versus verb-friendly languages, and draw general conclusions across the chapters.

The four steps of word learning, word segmentation, word mapping, word comprehension, and production, are inter-related and undergo refinement during and after the development of each step until language mastery is achieved. Although infants are prepared to learn language, accomplishing these milestones to learning words is hard work for the novice word learner, especially at first when one does not know much about how words work, or until infants have produced their first hundred words (Smith, 2002; Samuelson & McMurray, 2016). An important aspect about the word learning process is that infants' receptive vocabulary (the total number of words understood) is always in advance of their expressive vocabulary (the total number of words spoken after first word onset; Fenson, Dale, Reznick, Bates, Thal, et al., 1994) at any given time. Although the speech mechanism responsible for word production is always playing catch up to what a child comprehends throughout childhood and beyond, both receptive and expressive vocabulary are typically positively correlated (Fenson, et al., 1994). Simply put, infants who understand more words typically also produce more words. Consequently, by enhancing the first three steps of word learning early on, parents and professionals can help the novice word learner to build a solid foundation for an increased number of words yet to be spoken, eventually creating a sure path to preschool readiness and academic success. In this volume, the caregiver's important role in assisting the steps to word learning will be elucidated, with an emphasis on the first three steps of word learning.

Vocabulary development is a critical component of learning to read and write (Suggate, Schaughency, McAnally & Reese, 2018). A sizable percentage of children entering first grade each year show delays in their knowledge about words and how words work. Yet, until recently, according to the National Institutes of Health reading panel report (USA), a large body of research on vocabulary instruction and intervention has focused on this

language-delay problem after children's entry to the first grade (Kamil & Hiebert, 2005; 2009; Kuhn & Stahl, 1998) with little attention to children's learning prior to that period. The critical ages at which to promote language and communication have gradually decreased to include preschool children and toddlers (e.g., https://fpg.unc.edu/news/nc-pre-k-earns-high-marks-its-first-15-years), as researchers recognize the urgent need to prevent language delay by enriching teacher-child interaction as early as the pre-kindergarten years. It is unclear why this decrease in age has taken place over such a protracted period of time when even as early as the late 1970's it was evident, from reported individual cases of language deprivation (e.g., Curtiss, 1977), that the language environment plays a critical role in children's language learning early on, and that the earliest possible intervention is imperative to achieve typical language.

As a case in point, in 2017, the prestigious Frank Porter Graham Child Development Institute, University of North Carolina at Chapel Hill, recommended ten best practices to promote language and communication skills in young children on their website (FPG home, 2017, this webpage is no longer active). These ten best practices or strategies included – (1) *engaging in conversations with children, (2) giving descriptions of objects, activities or events, (3) using different types of words and grammar, (4) providing children with the names of objects or actions, (5) engaging in activities or objects that interest children, (6) using books to engage children's participation, (7) reading the same books multiple times, (8) introducing objects that spark conversations, (9) engaging in musical activities, and (10) using gestures or simple signs with words.* It is important to note that nine out of these ten strategies are focused on promoting language after children have learned to talk. In comparison, the primary aim of the present volume is to focus on best practices for building vocabulary from the ground up before infants have begun to speak or are in the first word stage of language development. After all, it is only by understanding how children develop a repertoire of words at the earliest stages of language development can we inform and engage in best practices in vocabulary enhancement long prior to its manifestation as a delay. Although, undoubtedly, promoting vocabulary development through reading and play to infants, toddlers and preschool-aged children is vital to building an already established basic vocabulary (Dickinson et al., 2019; Dunst, et al., 2012; Hassinger-Das et al., 2016; 2017; Toub et al., 2018), promoting word learning much earlier in time, when infants and toddlers first start to learn words, should be even more vital to establishing a strong foundation for vocabulary growth and preschool readiness.

Dwelling further on the ten specific language promoting strategies that adults could adopt while communicating with children specified by the Frank Porter Graham Child Development Institute, nearly half are targeted towards promoting *word learning*, namely - *giving descriptions of objects, activities or events, using different types of words and grammar, providing children with the names of objects or actions, engaging in activities or objects that interest children, introducing objects that spark conversations*, *and using gestures or simple signs with words*. However, no specific set of instructions to teachers and professionals on precisely how to go about giving descriptions, providing names, engaging in activities, introducing objects, and using gestures with words are provided. In contrast, a great deal of recent research underscores the highly specific nature of the practices that should assist in promoting word learning. These specific practices will be elucidated in the subsequent chapters of this volume.

In the following paragraphs, I outline the contents of each of the eight subsequent chapters contained in this volume. To reiterate, the overarching goal in these chapters is to illuminate the conditions that promote or facilitate learning in the novice word learner, using the scientific evidence at hand. Once we understand what facilitates the steps to word learning, we can better understand how to go about strategizing and enhancing each step to individual children's word learning.

Chapter 1, *Infants' First Words*, focuses on the very nature of the first words that infants learn, and its implications for the teaching of words to infants. Infants hear streaming speech all around them when caregivers and others speak directly to them or when speakers communicate to each other within earshot of infants. Which words do infants selectively attend to first when they start to separate (segment) words from these streams of speech? Which words do they first learn to pair with a specific object or action? And why are they more likely to learn some words more easily relative to others? Chapter 1 highlights the research that sheds light on these specific questions, aiming to introduce the reader to the world of communication from the infants' perspective, to elucidate the types of words infants first perceive, segment, and recognize from the speech stream, and learn the meaning for as they become acquainted with the world of communication.

Chapter 2, *Prosody Guides Word Learning*, focuses primarily on why baby talk matters to infants' and young children's learning of novel words (Golinkoff & Hirsh-Pasek, 2008; Ramírez-Esparza et al., 2014; Weisleder & Fernald, 2013). In addition, the role of infant-directed speech (Thiessen et al, 2005) in facilitating infants' segmentation of words is discussed. It also addresses how syllabic stress and rhythm help infants to learn words such as nouns and verbs and distinguish between them (e.g.,

Curtin, Campbell, & Hufnagle, 2012; Shukla et al., 2011), and how the position of a novel word in a sentence enables infants to attend best to it (Fernald & Mazzie, 1991).

In Chapter 3**,** *Space and Body Matter*, research findings that illustrate how adults, when naming objects and actions, manipulate the space between themselves and their infants (Dueker & Cunningham, 2010) are discussed, as well as other manipulations of space to enhance language. For instance, some studies illustrate that naming objects consistently in the same space makes it easier for infants and toddlers to learn the names for those objects (e.g., Samuelson et al., 2011). Next, I illustrate that infants' and children's developing physical ability correlates with their speech and vocabulary development, suggesting that physical space plays a vital role in language development. Finally, I discuss some practical benefits of utilizing physical or motor abilities when teaching novel words to children using recent intervention research.

In Chapter 4, *Timing Perception Guides Word Learning*, recent findings on how the timing between a word and a moving object or an action facilitates infants' learning of words during mother-child interactions is described (e.g., Chen et al., 2015; Gogate et al, 2006; Gogate et al. 2000; 2013; 2015; Gogate & Maganti, 2017; Zukow-Goldring, 1997). In addition, the important role of caregivers' simultaneous naming and touch (Seidl et al., 2015) in gaining infants' attention to words is examined in detail.

In Chapter 5, *Gesture and Touch Guide Word Learning*, the influence of caregivers' gestures and touch on infants' word learning is examined in detail using the research at hand (e.g., Brand et al., 2002; Brand & Tapscott, 2007; Chang et al. 2016; Suanda et al., 2016; Matatyaho, 2008; Matatyaho-Bullaro, et al., 2014). For instance, when mothers name objects or actions for their 6- to 8-month-olds in naturalistic interactions, they often shake or rotate a hand-held object of interest while naming it (e.g., Gogate, Maganti, & Laing, 2013; Nomikou, Koke & Rohlfing, 2017). Furthermore, how caregivers' pointing gestures towards an object or event of interest facilitate infants' word learning is discussed at length (Özçalişkan & Goldin-Meadow, 2005; Namy & Waxman, 1998).

In Chapter 6*, Joint Attention and Word Learning*, the important role of joint or shared attention, when caregiver and infant attend to the same object or event, in word learning contexts is examined (e.g., Morales et al., 1998; Yu & Smith, 2013; Gogate et al., 2006; Brooks & Meltzoff, 2008). The ability to share attention undergoes many developmental changes. These developmental changes, in turn, play a role in infants' word learning.

Chapter 7*, Bilingual versus Monolingual Word Learning: Similarities and Differences in the Early Years*, focuses on recent empirical research

which suggests important variations in the developmental timing of specific language milestones in bilingual versus monolingual language learners. Remarkable differences in receptivity to the basic building blocks of language(s) are evident even at birth (Byers-Heinlein, Burns, & Werker, 2010), and persist in the early years due to exposure versus the lack of it to an additional language starting in the womb. How else might bilingual and monolingual infants differ in their language learning? In this chapter, I highlight some of the differences as well as similarities between bilingual and monolingual learners in their receptive and expressive vocabulary development in the early years, owing to continued exposure to differences in their language environment. The implications of these differences for language education, in particular, preschool language readiness are also discussed, given that age-appropriate vocabulary development plays a key role in children's grammar and literacy development.

The final chapter, Chapter 8, *Conclusions, Questions and Future Directions***,** draws general conclusions from the research discussed in prior chapters. Caveats or limitations of these findings, if any, are discussed. For instance, not all strategies discussed in the prior chapters might work with all infants due to variations in word learning across cultures around the world. Similarly, not all strategies will work with toddlers experiencing word-learning delays or with children with either visual or hearing impairment. Strategies for teaching words to the atypically developing child may vary. For example, taking away the face while naming to the child, helps children with Autism Spectrum disorder to learn the names for objects (Patten et al., 2017). As yet unresolved questions and further directions are highlighted as well, with the goal to inspire further research particularly in the domain of early language intervention.

CHAPTER ONE

INFANTS' FIRST WORDS

Infants hear streaming speech all around them when caregivers and others speak directly to them or when speakers communicate with each other within earshot of infants. Which words do infants selectively attend to first when they start to separate (segment) words from these streams of speech? Which words do they first learn to pair with a specific object or action? And why are they more likely to learn some words more easily relative to others? This chapter highlights the research that sheds light on these specific questions. It attempts to introduce the reader to the world of communication from the infants' perspective, to elucidate the types of words infants first perceive from the speech stream, and learn the meaning for, as they become acquainted with the world of communication. Once we understand which words infants learn first, and how and why they learn these words, parent-implemented interventions could be designed to focus on teaching the same types of words to children in need of greater assistance and intervention to acquire a vocabulary.

Frequency Builds Familiarity

Broadly speaking, when infants attend to speech in their language environment, they attend to and perceive the acoustic properties of words that are more frequent right from the start. For this reason, even English learning newborns discriminate between lists of lexical words that are relatively limitless (words that refer to tangible entities in the world- such as nouns, verbs, adjectives and adverbs) but not grammar words that are relatively limited (such as in English, the articles the and a, and the prepositions in and of; Shi, Werker, & Morgan, 1999). By 6 months of age, infants listen longer to and show a robust preference for lexical words relative to grammar words (Shi & Werker, 2001). As another example of greater frequency building familiarity, researchers have found that infants become familiar with the sound of their own name fairly early on. Around 4 months of age, infants preferred to hear their own name relative to other names even if that other name contained the same number of syllables as

their own name, suggesting a high level of familiarity and recognition of the sounds of their own name (Mandel, Jusczyk, & Pisoni, 1995). Although a large proportion of initial input to infants consists of words in isolation (Keren-Portnoy, Vihman, & Fisher, 2018), a further study found that around 6 months, infants use their own familiar names as anchors to segment other new words in sentences (Bortfeld, Morgan, Golinkoff, & Rathburn, 2005). Thus, infants separated novel words better if the novel words (e.g., ball) were embedded in phrases or sentences which also contained the infant's name than if the same sentences did not contain the infant's name (e.g., "Katy, look at the ball" versus "Look at the ball!". These findings suggest that the greater frequency of words in the input creates familiarity with the words. Thus, the infants' own name becomes familiar and plays an important anchoring role in initiating young infants to other novel words and into the communicative world. In this manner, the caregivers' frequent use of infants' names in sentences could assist infants in attending to and segmenting other novel words, such as labels for objects in the speech stream.

Similarly, word familiarity dictates which specific word classes infants learn first. In noun-dominant languages where nouns occur more frequently relative to verbs (e.g., English), and are used more often in the language addressed to infants, infants tend to learn more nouns (known as the noun-bias) and learn them far earlier than other word classes such as verbs, adjectives or adverbs (e.g., Kim, McGregor, & Thompson, 2000). In comparison, in verb-dominant languages where verbs occur far more frequently relative to nouns (e.g., Telugu), and are used more often in the language addressed to infants, the infants learn verbs relatively early and to a far greater extent (Reddy, Liebal, Hicks, Jonnalgadda, & Chintalapuri, 2013).

Word familiarity also plays an important role when infants begin to put words and persons together and comprehend the words (i.e., knowing that the word stands for a specific person). Thus, by 6 to 9 months, infants know the meanings of many common nouns and verbs that they are likely to hear often in their immediate environment (Bergelson, & Swingley, 2012; 2013). Commonly occurring concrete nouns such as "Mommy" and "Daddy" tend to be favored over less commonly occurring words and are generally learned first. Thus, even 6-month-olds looked longer when they were shown pictures of their own mother and father while hearing the words "Mommy" or "Daddy" relative to pictures of another infant's parent of the same gender (Tincoff, & Jusczyk, 1999). These findings suggest that as early as 6 months of age the words refer specifically to their own parents of a particular gender, and not generically to all parents of the specific gender.

Furthermore, familiarity plays an important role in the learning of words that refer to body parts. For example, research has shown that at about 6 months, infants know the names for their own body parts such as "hands" and "feet" and can pair them with the specific body-parts (Tincoff, & Jusczyk, 2012). During their first year, infants also learn novel, nonsense words such as "bopita" when paired with body parts such as knee and elbow, if an experimenter touches those parts while speaking the novel utterances (Tincoff, Seidl, Buckley, Wojcik, & Cristia, 2019). In their second year as well, toddlers are highly inclined to produce words that refer to body parts, which is well established in standardized language assessments (e.g., MacArthur-Bates Communicative Development Inventory–MCDI; Fenson, et al., 1994). Even in the third year, they produce words that refer to their own actions involving their body parts prior to actions involving others' body parts (Huttenlocher, Smiley, & Charney, 1983).

The frequency of body-part words in the language input to infants plays a critical role in infants' learning as well, as it is clearly established that body-part words are abundant in speech and language directed to infants (Maouene, Hidaka, & Smith, 2008). Similarly, names for objects manipulated by body parts (e.g., hands) are highly frequent in language directed to infants, and are said to have a high body-object interaction index (BOI; Pexman, Muraki, Sidhu, Saikaluk, & Yap, 2019). Additionally, certain body part words are easier to learn because infants' own hands and feet or the actions they can perform (what is being referred to - the referent) are available at close proximity for them to explore, and therefore, are highly familiar by the time infants begin to learn the names for them around 6 months. Infants, in the first few months of life, spend a long number of their waking hours visually exploring their own hands and feet as well as mouthing them, and perceive their own face and body (e.g., belly button) in their first year. Finally, added familiarity and greater opportunities to explore and be messy with nonsolid objects (e.g., salt, sugar, and liquid substances) when seated in a high-chair rather than a table allow for greater learning of the names for those substances at 16 months (Perry, Samuelson, & Burdinie, 2014).

In summary, the findings taken together suggest that familiarity, mediated by greater frequency of certain words relative to others in the input language, impacts early language learning and, in particular, vocabulary learning (Goodman, Dale, & Li, 2008). Thus, greater frequency of specific words in maternal input to 7-month-olds predicts earlier learning of those words by infants in the second year (Newman, Rowe, & Bernstein, 2016). Additionally, greater familiarity with the object or the action that is being referred to also contributes to infants' learning of first words. Using a head-

mounted camera on infants of 8.5 to 10.5 months of age during eating activities, researchers have established that the world view of these infants consists of a very small set of highly frequent objects present on the scene (e.g., a bowl, and a spoon; Clerkin, Hart, Rehg, Yu, & Smith, 2017). Consistent with this view on word and referent familiarity, adults' greater naming frequency enables infants to perceive the commonalities between objects of the same kind (e.g., doggie for all types of dogs, Althaus & Plunkett, 2016). The significant impact of word familiarity resulting from greater word frequency in the input as well as familiarity with the referent (e.g., infants own hands or feet) on infants' vocabulary learning is further underscored in the next two subsections of the present chapter.

The Perceived Similarity between Words and Objects and Early Word Mapping

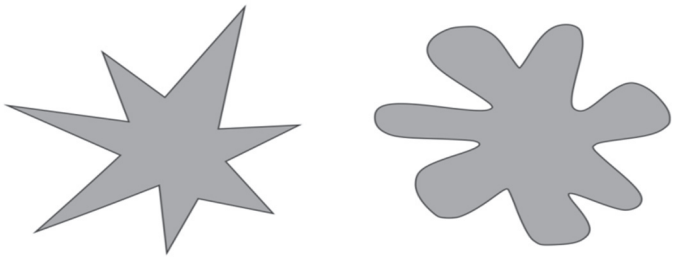
The role of familiarity during early word mapping (learning to put words and objects together) also extends broadly to the extent of perceived similarity between the words and the objects or actions to which they refer. In other words, when words sound similar to or resemble the physical properties of the specific objects or actions to which they refer (are sound-symbolic), infants learn the word-object pairs more easily and at an earlier age, around 4 months. Thus, young infants are quite adept at learning, for example, that a rounded object goes with a word such as *mamo*, whereas a jagged object goes with a word such as *kiki* (Asano et al., 2015). When these sound-symbolic word-object relations are interchanged or mismatched, infants look longer to them than when they are matched, and show significant brain wave activity in specific regions suggesting that they detect a mismatch between what they hear and see.

The resemblance between words and their referents is particularly salient when infants and toddlers have a small number of words in their receptive or productive repertoire (Imai et al., 2008; Imai & Kita, 2014). Because infants use the similarity between sounds and sights to learn new words early on, one possible way to learn to put together (map) specific words and specific objects might be to use perceptual familiarity with the sounds of words to find perceptually similar objects. As infants' vocabulary increases, infants rely less on the similarity between the words and the actions or the objects for which they stand (Laing, 2017; also see Brand, Monaghan, & Walker, 2018; Perry, Perlman, & Lupyan, 2015). As was discussed in the prior section, infants show evidence of learning word-object relations, where the words bear no resemblance to the objects to which they refer, a bit later, around 6 months based on the frequency and

familiarity of the objects (e.g., hands and feet, Tincoff & Jusczyk, 2012). Recent evidence suggests that infants, as young as 8 months of age, also learn novel word-action relations, such as *wem* paired with a *shaking action*, and *baf* paired with a *looming action* of an object, where the words bear no resemblance to the actions to which they refer (Gogate & Maganti, 2017).

Although infants can learn word-object and –action relations of both types, words that bear a resemblance to their referents and words that do not bear a resemblance to their referents, even toddlers and adults easily learn the relations between novel words with rounded sounds (of a lower pitch), such as *bouba,* and rounded objects and words with sharp sounds (of a higher pitch), such as *kiki,* and jagged objects with sharp edges (see Figure 1-1 below), attesting to their use of sound-symbolism to learn novel words. Furthermore, they find the mismatched words and objects to be a violation of their expectation by looking longer to them (Maurer, Pathman, & Mondloch, 2006; Ramachandran & Hubbard, 2001). Research across cultures suggests that Japanese and American mothers use sound-symbolic words abundantly during naming to their toddlers in context, and that the toddlers learn such sound-symbolic words better than non-sound-symbolic ones (Yoshida, 2012). Recent findings have shown that even 3-year-old British-English speaking children learn novel sound-symbolic verb-action relations easily and remember these relations a day after they first learned the relations (Kantartzis, Imai, Evans, & Kita, 2019).

Figure 1-1: The words, *kiki* and *bouba*, presented with objects of a jagged or rounded shape in the word-mapping experiments (adapted from https://en.wikipedia.org/wiki/Bouba/kiki_effect).



These cross-cultural research findings clearly illustrate that the sounds of words matter during word learning, and sound-symbolic words are abundantly used in caregivers' communication to infants and toddlers. Although sound-symbolic relations matter significantly more, when the number of words that children already know are relatively small, older children with well-established vocabularies as well easily learn these novel sound-symbolic relations and remember them in the long-term.

Distinct Versus Similar Sounding Words and Early Word Learning

Speech perception, in particular the sounds that make up words, clearly influences word learning (Werker & Yeung, 2005). Evidence that the sounds of words matter during early word learning can also be seen in word-mapping experiments that require infants to put novel words and objects together and present infants with similar versus distinct sounding words closely in time during a word-mapping task. For example, at about 6 to 7 months, if infants are presented with two novel words, such as *Gow* and *Chi*, each paired with an object, infants are able to learn the word-object pairings under optimal conditions (e.g., when mothers name the objects simultaneously with object motion). Given words and objects under similar optimal conditions, in experimental studies as well, 7-month-old infants also pair highly distinct novel words such as *tah* and *gih*, with two objects, but not similar sounding words such as *tah* and *gah*, with the same objects. A month later, however, 8-month-old infants are able to pair the same similar sounding words under the same conditions. These findings suggest that the words infants encounter could range from being very distinct to highly similar, and that making novel words distinct from one another makes it easier for infants to learn the words, when the words occur closely in time.

This word distinctness-similarity continuum interacts, once again, with the relative familiarity of the words during toddlers' learning of word-object mappings. For example, at about 14 months of age, infants are known to experience difficulty during word-mapping tasks when the novel spoken syllables sound very similar such as *bih* and *dih* (Stager & Werker, 1997) but have no difficulty when the novel spoken syllables are highly distinct such as *neem* and *lif* (Werker, Cohen, Lloyd, Casasola & Stager, 1998). However, by 20 months, infants map similar sounding syllables, such as *bih* and *dih*, onto objects (Werker, Fennell, Corcoran, & Stager, 2002). Of further significance to word learning, if the words presented in word-mapping tasks are familiar to the toddlers, even 17-month-old toddlers

successfully map the similar sounding words onto objects (Fennell & Werker, 2003). These findings suggest that during word learning, the distinctness-similarity continuum interacts with the relative familiarity versus novelty of the words themselves.

The ability to attend to similar sounding words, to pair them with objects for instance, and learn their meanings, no doubt, are a quintessential part and parcel of vocabulary building and development. Vocabulary building, in turn, is fundamental to later developing language and pre-literacy skills such as awareness of the sounds of words (phonemic awareness) in 4- to 5-year-old children, a prerequisite for reading development. For example, four to five-year-old (preschool and kindergarten age) children attend to and discriminate the word-initial sound /p/ from /b/ in familiar words, such as pencil, bear, box, and bell. If shown pictures of the objects along with the accompanying words they correctly identify the different word after attending to the word-initial sounds. By the time children are about 6 years of age (in first-grade), they also attend to and discriminate word-final sounds (Yavas, & Gogate, 1999). Thus, they are quite adept at deleting, for example, the sounds /k/ and /t/, from the ends of words such as peak and fleet. Once again, greater mastery of vocabulary or familiarity with words in the preschool years predicts greater awareness of the phonemes or sound patterns that make up those words in the first and second grades of elementary school (Silvén, Poskiparta, & Niemi, 2004).

Summary and Potential Applications of the Research Findings

The research reviewed in this chapter illustrates that the everyday input provided by caregivers can have cascading effects on infants' word learning. Typically language learning infants attend to the relative frequency of words in caregivers' speech (e.g., their own name, or words such as Mommy and Daddy). The added exposure to specific words creates familiarity with those words. Further, familiarity with an infant's own name serves as an anchor to segment other novel words. In this manner, infants learn to segment novel words in a sentence by using familiar words as an anchor. Next, the research presented in this chapter suggests that early word learning can be facilitated if words and objects bear a sound-symbolic relationship, where there is a perceptual similarity between the words and the objects to which they refer. Thus, infants and children could use perceptual familiarity with the sounds of words to select perceptually similar objects or actions on the scene. Further, the research showed that when novel words are presented to infants closely in time, they learn to put

them together with objects better if the words sound distinct than if they sound highly similar. However, when the words are familiar, toddlers are able to pair the similar sounding words with the objects easily.

Given these findings on word familiarity and word learning, it is plausible that in cases of language delay, parent-implemented language intervention (Roberts & Kaiser, 2011) strategies could enhance infants' familiarity with words that, in turn, could facilitate their word learning. For example, a concrete strategy for enhancing word learning and, in particular, for increasing word segmentation early on in infants with early language delay could be to have caregivers use infants' and toddlers' name with greater frequency when naming novel objects and actions for their novice word learners. A second strategy for enhancing word learning could be for parents to use sound-symbolic (e.g., animal sounds with appropriate stuffed toy animals) words more often, especially during early word learning. A third strategy would be for parents to use distinct words more often early on for their infant in naming contexts. Given the high degree of variation in caregivers' speech to infants, not all parents might use these strategies spontaneously. Therefore, optimal usage of such concrete strategies by parents and caregivers, if they are not naturally occurring during infant-caregiver interaction, could facilitate infants' and young children's vocabulary development while making caregivers more aware of how to go about gradually easing their child into the world of words.

CHAPTER TWO

PROSODY GUIDES WORD LEARNING

Infants, toddlers and children attend to a lot more than just the sounds or segmental components of words when they hear everyday speech. A wealth of evidence from developmental research suggests that they attend to the rhythm, pitch variations, specific intonation patterns, and timbre, referred to broadly as prosody, and that they skillfully use the prosodic (suprasegmental) properties in adults' speech to attend to and segment or separate words from the speech stream. Exactly how does prosody assist early word learning? To fully address this question, we must first address the unique prosodic composition and characteristics of speech typically directed to infants and toddlers, and its relative salience to infants and toddlers compared to speech that is directed to adults. In the present chapter, therefore, first, the prosodic properties of infant-directed speech (IDS) and how infants respond to them relative to their response to adult-directed speech (ADS) will be highlighted. Second, how specific types of prosody facilitate infants' and toddlers' vocabulary development will be addressed, focusing specifically on their word segmentation, mapping, comprehension and production.

Prosodic Modulations in Infant-Directed Speech

Across many cultures, speech directed to infants, toddlers and young children sounds very different compared to speech directed to adults (Byers-Heinlein et al., 2021). For instance, Fernald, Taeschner, Dunn, Papousek, de Boysson-Bardies et al. (1989) examined mothers' and fathers' speech to infants of 10 to 14 months and to an adult after recording their speech samples during home observations of their semi-structured interactions. The parents spoke French, Italian, German, Japanese, British or American-English. Speech samples were compared across many prosodic modifications such as the mean pitch (mean fundamental frequency), pitch range and variability, utterance duration and pause duration. In general, parents who spoke American English used many more modifications such as shorter utterances, greater pause durations, and more exaggerated pitch

patterns relative to the parents of other language groups to their infants in comparison to adults. More importantly, mothers but not fathers across all language groups used a higher mean pitch and a greater pitch range to their infants than to an adult. A plethora of research findings have firmly established the unique prosodic properties of mothers' speech modulations directed to infants and toddlers (Fernald & Mazzie, 1991; Fernald & Morikawa, 1993; Fernald & Simon, 1984; Kitamura & Burnham, 2003; Kitamura, Thanavishuth, Burnham et al., 2001; Masataka, 1992). These studies establish that in addition to the greater average pitch and pitch pattern variation, mothers' prosodic exaggerations to infants contain a slower rate of speech with elongated vowels in their spoken syllables.

While the findings on maternal speech modulations in IDS are well established, the findings on fathers' speech modulations have been mixed. To reiterate, Fernald et al. (1989) did not find a higher average pitch or greater pitch range in fathers' speech to 10- to 14-month-old infants from several language backgrounds such as French, Italian, German, Japanese, British or American-English. More recently, Broesch and Bryant (2018) examined the prosody of fathers' infant-directed speech across two cultures, American and Vanuatu. In contrast to Fernald et al. (1989), the authors found that fathers from both cultures used a greater pitch range when speaking to their infant relative to when speaking with an adult. However, the average pitch of the Vanuatu fathers, but not the American fathers (similar to Fernald et al., 1989), was greater to their infant compared to the adult. Further, the American fathers alone slowed their rate of speech to their infant. These findings taken together suggest that although fathers from many different cultures use a wider pitch range, fathers from some cultures may not use a higher average pitch when speaking to infants.

Broadly speaking, these findings suggest that maternal speech directed to infants across cultures is unique, despite cultural variations, and might have evolved to serve the purpose of recruiting infants' attention to speech and communication. In the next sections, I will elaborate on the research that shows that the exaggerated manner of speaking recruits infants' attention, makes phonetic distinctions more salient (Kuhl et al., 1997), facilitates word segmentation (Singh, Nestor, Parikh, & Yull, 2009) and word learning (Graf Estes & Hurley, 2013).

Infants' Attention to Infant-directed Speech

Both monolingual and bilingual infants, especially those who hear North American English, show a preference for infant-directed speech (IDS) over adult-directed speech (Byers-Heinlein et al., 2021). Infants

especially like listening to maternal speech directed to them. Fernald (1992) first suggested that mothers' speech is a biologically relevant signal and that typically developing human infants tune into their specific properties during social interaction because it is critical to their survival just as recognizing the maternal calls of any other mammalian species is critical for the survival of the young of that species. This biological view explains findings from scientific studies which illustrate that infants first tune into the prosody (rhythm and intonation patterns or pitch variability) of their mothers' speech in the womb. Consequently, at birth, they show a listening preference for their own mother's voice over that of a female stranger by sucking harder on a pacifier to keep their mother's voice playing via headphones rather than sucking at a slower rate to keep the stranger's voice playing (Fifer & Moon, 1995). More recent research established that this listening preference is only observed when newborns are presented with long strings of utterances such as stories or nursery rhymes prior to birth but not when the mothers and strangers use a single word such as "baby" (Moon et al., 2015). These findings suggest that newborns specifically tune in to the prosody or rhythm of the longer speech strings rather than to individual words when tuning into their mother's voice.

Infants continue to show a listening preference for infant-directed speech over adult-directed speech throughout their first year (Cooper & Aslin, 1990). For example, Cooper, Abraham, Berman, and Statska (1997) used a procedure in which infants of one and 4 months were able to control the voice that was played by their sustained looking to a checkerboard pattern. The 4-month-old, but not the 1-month-old, infants showed a specific listening preference for maternal infant-directed versus adult-directed speech. The 1-month-olds, however, did show a preference for ID speech when they heard a stranger's voice. Based on this evidence, the authors suggested that the preference for maternal ID speech develops over time (also Cooper & Aslin, 1994), and is counterevidence to the view that infants are born with the natural propensity to detect and prefer their own mothers' voice (e.g., Fernald, 1992). Reconciling these opposing views, an alternative possibility is that infants tune into and learn the properties of their mother's voice in the womb, consequently showing a preference for it at birth (Fifer & Moon, 1995). Subsequently, the preference might become stronger or weaker during different points in development depending on various factors. One experimental study provides evidence for such preference variations at different ages. Using a head-turn preference procedure, where infants from 4 to 14 months were trained to turn their head to the left or right to show a preference for ID versus AD speech in English or Japanese, Hayashi, Tamekawa, and Kiritani (2001) found a U-shaped

preference for ID speech across infants from the two language backgrounds at different ages. Across language backgrounds, the youngest infants at 4 months and the oldest infants at 14 months showed a clear listening preference for ID speech, whereas the preference diminished temporarily in between these ages. However, in general, the infants preferred ID speech in their native language over the non-native language.

Other research shows that infants prefer listening to the prosody of infant-directed speech throughout infancy even at older ages. For instance, 10- and 16-month-old infants prefer the higher pitch and pitch variability of infant-directed speech streams to the shorter utterances and greater word repetition that are also characteristic of infant-directed speech (Segal & Newman, 2015). What exactly carries the higher pitch and variability in infant-directed speech? Zang, Koerner, Miller, Grice-Patil, Svec, Akbari, Tusler, and Carney (2011) showed that 6- and 12-month-old infants' brain is highly sensitive (showing an enhanced response in the right brain) to the hyperarticulation and elongated vowels (i.e., exaggeration) in infant-directed speech. Several behavioral studies have consistently shown that hyper-articulation in infant-directed speech is highly salient to young infants, is associated with enhanced phonetic learning in the native language (e.g., Liu, Kuhl, & Tsao, 2003), and enables infants to learn the phonetics of their language (Kangatharan, 2014). Furthermore, research has established that mothers adapt their speech by decreasing the hyperarticulation in speech directed to children of 5 years compared to the same group in their first year (7 months to 1 year; Liu, Tsao & Kuhl, 2009).

Why do infants prefer ID speech over AD speech? One possible reason for this preference is that ID speech contains more "happy talk" than AD speech (Singh, Morgan, & Best, 2002) with a far greater extent of positive intonation patterns and affirmations rather than negative ones. Infants' preference for ID speech extends beyond the voice to faces that produce ID speech as well. Consequently, 3- and 5-month-old infants look longer at faces when they produce ID speech even if the voice is muted. This preference does not hold when the same persons are producing adult-directed speech, suggesting that infants prefer the animated and mostly happy expressions of ID producing faces to faces that are producing adult-directed speech (Kim & Johnson, 2014). As another example, when 4.5 and 9-month-old Cantonese and English learning infants are shown videos of a female speaking to her infant versus an adult in either Cantonese or English, infants of both language groups overwhelmingly preferred the ID speech videos over the AD speech videos, regardless of language (Werker, Pegg, & McLeod, 1994). A recent study has shown more specifically that 4-month-old infants attend to changes in prosody in infant-directed speech

passages if a speaker's face and voice are synchronized but not if they only experience either the face or voice alone (Bahrick, McNew, Pruden & Castellanos, 2019). These findings, taken together, suggest that infants' prefer the animated expressions that match with the hyperarticulation and other prosodic features of infant-directed speech across face and voice.

Furthermore, infant-directed speech across voice and face functions in tandem with other cues such as caregiver's eye-gaze to help infants disambiguate whether the caregiver is addressing them or someone else on the scene. In fact, an adult's direct gaze towards 6-month-old infants during infant-directed speech elicits enhanced brain responses in regions involved in processing auditory and visual aspects of social communication. These enhanced brain responses are elicited during naturalistic conversations when two adults and another infant are present on the scene (Lloyd-Fox, Széplaki-Köllőd, Yin, & Csibra, 2015). In Chapter 5, I will delve deeper into the visual body movements or gestural actions that accompany ID speech and recruit infants' attention to words.

Prosody in Infant-Directed Speech Guides Word Segmentation and Recognition

Infants easily separate or segment words from the speech stream when caregivers or other adults use ID speech. For instance, 6.5 to 7.5 month-old-infants in the United States learn to separate consistently co-occurring nonsense syllables (words) from a string of nonsense syllables if the strings are presented in ID speech but not if they are presented in AD speech (Thiessen, Hill, & Saffran, 2005). British English infants as well segment words only when they hear exaggerated ID speech with elongated vowels (Floccia, Keren-Portnoy, Depaolis, Duffy, Luche, Durrant, White, Goslin, & Vihman, 2016). Furthermore, 7- to 8-month-old infants remember the words that they segment from sentences, over long periods of time, if the sentences are presented, once again, only in ID speech (Singh, Nestor, Parikh, & Yull, 2009). Greater use of ID speech to infants at home is also associated with better word recognition at 24 months (Weisleder & Fernald, 2013), suggesting that the quality of speech to infants matters.

Infants typically start to segment nouns and verbs from the speech stream early during their first year. Exactly how do the unique prosodic characteristics of ID speech assist infants in their ability to segment these words? Mothers are known to consistently place novel words with the highest pitch in the final position of their utterances (Fernald & Mazzie, 1991). Infants in turn might detect nouns and verbs using prosodic cues that differentiate them from grammatical words. For example, infants learning

Mandarin-Chinese distinguish between nouns and verbs in maternal ID speech based on the prosodic differences between these word classes, such as the pitch of the second syllable, and the duration differences between the first and the second syllable (Aijun, Shi, & Zhao, 2011). Maternal ID speech to 4- and 11-month-old infants clearly distinguishes between nouns and verbs in French, once again, based on vowel duration within the syllables. However, ID speech distinguishes more on the basis of pitch (fundamental frequency) to the older infants who are more likely to be learning these words (Shi & Moisan, 2008). Further studies are needed to determine whether English learning infants can distinguish between nouns and verbs based on possible prosodic differences. Even newborns who hear a list of words from different languages (Cantonese, Mandarin, Punjabi, Tagalog, Spanish, French, German) distinguish nouns or verbs from other grammatical words (Shi, Werker, & Morgan, 1999), and 6-month-olds show a clear listening preference for nouns or verbs over grammatical words (Shi & Werker, 2001).

These findings from infants' word segmentation and the prosodic characteristics of mothers' ID speech taken together underscore that infants utilize the prosody of words to separate them from the speech stream and likely also use prosody to distinguish between words such as nouns and verbs in speech directed to them. The next three subsections will further elucidate the important role that prosody in infant- and child-directed speech plays in word-object or -action mapping, comprehension and production.

Prosody in Infant-Directed Speech Guides Word-Object and -Action Mapping

Research has clearly established that ID speech makes putting words and objects or actions together (word mapping) easier relative to AD speech. For example, 17.5-month-olds were exposed to specific words, either *timay* and *dobu* or *nomay* and *gabu,* each paired with one of two interesting objects (Graf Estes & Hurley, 2013). Following initial exposure to the two word-object pairs, infants were tested with the same pairs versus interchanged or switched pairs to examine if infants had learned the original pairings and would look longer when the pairings were interchanged. In one experiment these researchers presented the word-object pairs in ID speech, with a higher pitch, more pitch variation and slower tempo with greater vowel elongation. In another experiment, the researchers presented the same word-object pairs in AD speech without the pitch modulations and exaggerated vowels. The infants only learned the word-object pairs in the experiment that used ID

speech, suggesting that ID speech modulations assist infants in learning word-object pairs.

Using a different method, Ma and colleagues as well have found that English learning infants of 21 months learned word-object relations under conditions when the words were uttered using ID speech but not when the same words were uttered using AD speech (Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011). However, at an older age (27 months), infants reliably learned the word-object relations when the words were uttered in AD speech, suggesting that early word-mapping, when infants are still learning to put words and objects together, is made easier under conditions when caregivers use ID speech.

Other prosodic properties that are specific to the native language also guide early word-mapping. Infants, in turn, tune into the prosodic patterns of their native language in the first year of life and use it reliably to learn words. For example, 6-month-old infants use the prosody in phrases, in particular the rhythm and recurrence of syllables, to assist them in putting novel words and objects together (Shukla, White, & Aslin, 2011). As another example, older English learning infants, at 16 months, also learn to pair nonsense words with actions, once again, only when the bi-syllabic words mimic the stress patterns of verbs in the English language (iambic-weak-strong), but not when the stress pattern mimics those of nouns in English (trochaic-strong-weak; Curtin, Campbell, & Hufnagle, 2012). In the case of languages where changing the pitch-accent changes the meanings of words, such as Japanese, 18- but not 14-month-old infants learn two word-object pairings when the words differ only in their pitch accent (Mugitani, Kobayashi, Hayashi, & Fais, 2019). Once again, these results show that toddlers' learn prosodic features critical to word learning that are specific to their native language.

Some research suggests, in contrast, that the structural characteristics of child-directed speech (e.g., the timing between word repetitions) might influence word learning more than the prosodic characteristics of child-directed speech, especially at older ages, once children are able to rapidly learn words. For instance, at 24- to 35 months, children learned to easily put together three novel words (*fep*, *coro*, and *dax*) with objects, if the novel words are repeated successively in sentences (e.g., "Do you know what a fep is?/Wow, this fep looks neat./Can you find the fep there?"; time between repetitions of the same word, 3.31s) rather than if each of the three words appeared in a random order and farther apart in time in the same sentences (e.g., "Do you know what a fep is?/Wow, this coro looks neat./Can you find the dax there?"; time between repetitions of the word, 15.69s; Schwab & Lew-Williams, 2016). As already discussed in Chapter 1, caregivers

naturally tend to repeat novel words successively in sentences when talking to their infants and young children, and this repetitive structural quality of child-directed speech facilitates word learning at older ages.

In summary, these findings taken together suggest that, in the first and second years, infants rely on prosodic cues (e.g., greater pitch, more pitch variation slower tempo with greater vowel elongation, and rhythm) in child-directed speech early on to map words onto objects or actions. In contrast, at older ages (by 27 months), they rely less on these prosodic properties, and consequently, are able to learn word-object mappings even if they are presented in adult-directed speech. In addition, if presented with child-directed speech, they rely more on its structural properties, such as novel word repetition, rather than the prosodic properties of speech to learn novel word-world mappings.

Prosody in Infant- or Child-Directed Speech and Word Comprehension

Beyond segmenting words and putting them together with either actions or objects, an important step to building a vocabulary, discussed in the Introduction of this volume, is for infants to learn what the words mean or word comprehension. The present section elucidates research illustrating how infants use prosodic characteristics of speech to understand the meanings of words.

In the previous section, the research reviewed suggested that at younger ages (prior to 2 years) infants use prosodic properties of infant- or child-directed speech (CDS) to learn word-object or action relations but at older ages they rely less on these acoustic properties, and more on its structural properties, eventually learning word-object relations in adult-directed speech (ADS). A similar pattern can also be observed in children's word comprehension. Experimental research suggests that when infants of 10 to 21 months are presented with familiar words in CDS or ADS and are trained with novel words in CDS while showing them with objects, the toddlers comprehend the meanings of the novel words in the CDS condition but not in the ADS condition (Foursha-Stevenson, Schembri, Nicoladis, & Eriksen, 2017). In the same study, in a different experiment, older 3 to 6-year-old children were given a task requiring them to comprehend whole sentences in CDS versus ADS conditions. The 5- to 6-year-olds understood the sentences in both CDS and ADS conditions. However, the 3- to 4-year-olds understood the sentences in the CDS condition but not in the ADS condition, once again suggesting that CDS is most influential early on during vocabulary development.

By 3 years of age, children have been found to differ in their vocabulary, based on several factors including their parents' socioeconomic status (SES) and education levels (Hart & Risley,1995) and their use of child-directed speech (Rowe, 2008) in naturalistic vocabulary learning contexts. Rowe's (2008) study investigated how parental language at home to young children from 2.5 to 3.5 years, across the SES spectrum, differed in the extent of CDS, and was related to children's vocabulary comprehension development. Three important findings emerged from this study with regard to parental use of child-directed speech in the home environment. First, the extent of child-directed speech used at home to children at 2.5 years predicted the extent of vocabulary at 3.5 years. Second, the extent of parents' use of child-directed speech was related to parental SES as measured by parental income and education levels. That is, greater parent SES was associated with greater use of child-directed speech. Finally, the extent of parental use of child-directed speech was mediated by parental knowledge about child development. These findings underscore the critical role that parental use of CDS on a day-to-day basis, including its unique prosodic characteristics, plays in young children's word comprehension and vocabulary development.

Prosody in Infant- or Child-Directed Speech and Word Production

Infants who hear more IDS directed at them have a larger expressive vocabulary at 2 years of age; the overall amount of speech (including ADS) overheard by children does not predict later vocabulary (Weisleder & Fernald, 2013). Findings such as these suggest that the greater extent of the unique properties of IDS including its structural and prosodic attributes infants hear, but not the overall amount of speech, predicts the extent of development of children's expressive vocabulary. A second study (Ramírez-Esparza, Garcia-Sierra, & Kuhl, 2014), examined the speech style (child-directed versus adult-directed speech) and social context (one-to-one versus group interaction) of parental language to infants (at 11 and 14 months) in natural contexts. The same infants' word production was measured at 11 and 14 months as well as later, at 2 years. The researchers found that greater amounts of parents' infant-directed speech to infants at 11 and 14 months during one-on-one parent-infant interaction was positively correlated with gains in word production at 11 and 14 months as well as at 2 years of age. These findings, once again, underscore the important link between infant- or child-directed speech and toddlers' as well as young children's expressive vocabulary development.

Implications for Early Intervention and Language Education

The research discussed thus far clearly illustrates that early language experience in the form of caregivers' infant-directed speech, including its structural and prosodic characteristics, are strongly linked to each step of word learning from word segmentation and mapping to word-comprehension and production. Given these research findings, can assisting or coaching caregivers to use infant-directed speech facilitate vocabulary development in their infants and children? Recent clinical research suggests that coaching parents to use infant-directed speech can, in fact, facilitate language development in infants and toddlers, in particular word learning. For example, Ramirez, Lytle, Fish, and Kuhl (2018) coached a group of parents (intervention group) when their infants were 6 months and 10 months of age on three measures – the optimal amount of child-directed speech, back-and-forth interactions, and parentese speech style. A second (controlled for socioeconomic status) group of parents were not coached in this manner. The three coaching measures and infants' language were measured at 6, 10 and 14 months in both groups. The infants in the intervention group showed greater development of babbling (vocalizing resembling speech) between 6 and 14 months and a greater number of words than the infants in the control group. These findings suggest that coaching parents on infant-directed speech can positively influence infants' word learning ability.

Similarly, Morningstar, Garcia, Dirks, and Bagner (2019) trained a group of parents (95% of Latino-Hispanic ethnicity) of typically developing 12- to 15-month-old infants to a brief home-based version of parent-infant interaction therapy (training to use greater amounts of IDS and change their prosody by using a greater pitch range) while a second group received standard pediatric care. Mothers' speech was analyzed in each group prior to and after intervention or prior to and after pediatric care. Mothers who received the parent-infant interaction therapy spoke with a greater pitch range and slower tempo post-intervention compared to pre-intervention. Mothers' use of a greater pitch range was positively related to infants' word production. These findings clearly illustrate that parental training to change their prosody and use greater amounts of infant/child-directed speech could benefit infants' language development. The findings are consistent with earlier research studies which suggest a positive correlation between the extent of parental infant-directed speech and infant language outcomes (e.g., Weisleder & Fernald, 2013), and that IDS lays the foundation for infants' language development (see review by Golinkoff, Can, Soderstorm, & Hirsh-

Pasek, 2015; Spinelli, Fasolo, & Mesman, 2017). Finally, siblings could also be coached to increase their use of IDS and positively impact infants' language development in cases of language delays, since in typical cases even 2-year-olds are known to use IDS to adapt to their younger infant siblings (e.g., Dunn & Kendrick, 2008).

CHAPTER THREE

SPACE AND BODY MATTER

Children encounter words that refer to objects located in a variety of places in their daily lives. Some words refer to objects that occur within or around the home, albeit, in different rooms (e.g., the microwave in the kitchen versus the bathtub in the bathroom), while other objects occur in specific outdoor environments (e.g., the swing or a slide in the yard or in a nearby park). Still others, such as a pacifier or a car seat, may be moved around from place to place along with the infant or toddler. It is no surprise then that word learning is constrained by the physical space in which objects and events occur. How does the space in which objects occur (or are placed by caregivers) influence how children learn the words that refer to those objects? In this chapter, I will first discuss the scientific research that illustrates how infants and children (and adults) use the physical space in which objects occur to learn and remember novel words, and how caregivers organize space around their infants' and toddlers' word learning in different ways. Next, I will discuss how the infants' ability to move in space is closely related to their language use including learning to produce words. Finally, I will summarize the important findings on how space matters when learning words, and suggest ways to use space when teaching words.

Putting Words and Objects Together in Space

How does the space in which objects occur help or hinder the learning of words and memory for the words? Novel word learning even by adults can be manipulated by the space and timing of object placement. For example, when given a single novel label such as *fep* and shown a dalmatian, adults assume that the label refers broadly to a dog. In contrast, if they are given the same label and are shown three different dalmatians simultaneously, they assume that the same word *fep* refers more narrowly to dalmatians and not just dogs (Xu & Tannenbaum, 2007). However, this highly specific reference to dalmatians can be tweaked by space and time. It becomes broader (i.e., referring to dogs) when the same dalmatians are presented one at a time and in different locations (Spencer et al., 2011). In

further contrast, this reference can revert to refer narrowly to a dalmatian, if the dalmatians are presented in the same location. These findings taken together suggest that, even for adults, learning a word for a category of objects is highly dependent on attention to and memory for the objects and their properties, which, in turn, are influenced by the space and timing of the appearance of the objects. If the objects appear in different locations, then learning the novel name for the objects requires greater memory. If only the most general characteristics of objects are remembered, even adults select the broader reference 'dog'. If, on the other hand, the objects are presented in the same location or even side-by-side, this requires less memory, and hence narrows the reference to a more specific one (i.e., dalmatian). Since even adults' attention and memory when learning novel words such as *fep* are constrained by the physical space in which the objects occur, how does space constrain the novice learner's word learning? To understand how infants begin to use space to learn words, we must first address what the preverbal infant knows about the sights and sounds that go together in their environment.

Infants perceive spatial relations in auditory-visual events very early on. It is well established that infants of 3 to 5 months detect mismatches or spatial separation in auditory-visual events. For example, infants look longer at video displays, when there is a physical separation between the sound and sight of a bouncing ball impacting a surface or speaking faces and voices compared to typical displays. Typically, these auditory-visual events are spatially co-located or emanate from the same location (Lawson, 1980). Newborns and 6-month-old infants tune into spatial co-location to learn the relation between otherwise unrelated but co-occurring sounds and sights of tones and bouncing animals (Morongiello, Fenwick & Chance, 1998), or the voices and faces of same sex individuals. Infants of about 7 months can be taught to arbitrarily relate or link two otherwise unrelated events. They can be taught that the face of one female person goes with the voice of another as long as the voice emanates from the same location as the specific face on an audio-visual display (Walker-Andrews, Bahrick, Raglioni, & Diaz, 1991; Walker-Andrews, 1994). This learning of arbitrary relations is closely related to learning that specific spoken words go with specific objects or events, which also involves pairing what is heard (the word) with what is seen (an object or event).

In any language, barring the limited set of sound-symbolic relations described in chapter 1, a large number of words and the objects or events that they stand for bear no resemblance to one another. Most are arbitrarily related to one another through convention. To the learner, prior to learning their relations, the words and objects or events may seem entirely unrelated.

Their relations must be learned through experience - one at a time, by attending to and interacting with a language expert, typically the primary caregiver. When first starting to learn to unify these arbitrarily linked words and objects, novice word learners however have a few strategies up their sleeve for linking the words with the specific objects. One such strategy that infants rely on is their ability to detect the spatial-colocation relations between words and objects or events to link novel words and the novel objects they encounter on an everyday basis. Samuelson, Smith, Perry, and Spencer (2011) found in their experiments, that toddlers, in their second year of life, similar to adults, learned new words for objects far better if the objects were consistently presented in the same locations (e.g., on the same side of a table located between the parent and the toddler). In contrast, if the locations of the objects were randomly switched, toddlers of the same age found learning the words for the same objects difficult. This finding clearly suggests that early learning of novel words is constrained by space. If the location of the objects is interchanged in experiments, it places more demands on the infants' memory and creates confusion for novice word learners when linking the novel words with the objects.

Caregivers intuitively organize "the naming space" for their infants and toddlers during play in a manner that facilitates infants' linking of novel words and objects in space. As a case in point, in typical middle-class American homes with infants or toddlers, caregivers typically organize their everyday caregiving activities around bath-time, play-time, napping, sleeping, and feeding routines. These routines typically involve specific toys or functional objects. For example, bath-time might include a rubber duck, a toy boat or other floatable toys. Feeding time likely includes flatware and utensils such as a spoon, a fork and a bowl or a plate, and a high chair. Nap time typically involves a book, a blanket, and perhaps calming music or a lullaby. These activities likely take place in different but specific locations in the home, and the objects typically stay in those same specific locations. In addition, Samuelson et al. (2011) reported that caregivers' consistent naming of specific objects in space was systematically related to their toddlers' (17-22 months) learning of those words in the specific space. In other words, caregivers who consistently named novel objects in a specific location had toddlers who learned the words far better than toddlers for whom caregivers named the same objects randomly placed in different locations. When caregivers switch the location of a novel object, it clearly creates confusion for their infants' and toddlers' learning of the novel word for the object. Similarly, naming an object in several locations, as opposed to one, hinders learning of novel word-object relations as early as 12-months (Osina, Saylor, & Ganea, 2013). In other

work, an individual child studied from 9-24 months was reported to produce words earlier if they occur in distinct spaces within the home (e.g., breakfast in the kitchen; Roy, Frank, DeCamp, Miller, & Roy, 2015).

Caregivers organize the naming space around their toddlers' word learning in other ways as well. For example, Dueker and Cunningham (2010) found that during interactions with infants, when mothers discuss abstract concepts (e.g., nouns such as *love*) they draw themselves closer to their infants as if to direct their attention to cues such as their own affect or emotions while speaking. In contrast, when discussing concrete topics (e.g., when naming concrete objects, such as *doggie*) mothers move themselves farther apart from their infant, while bringing forward the objects or events in space to highlight them, and bringing the objects closer to their mouth, making the novel object and the novel spoken word more spatially co-located or spatially unified.

The learning of such spatially co-located word-object relations is likely easier than the learning of spatially dislocated word-object relations. Increasing the spatial distance between a spoken word and what it refers to increases the degree of arbitrariness in the relation between the word and the shown object, making the relation harder to learn. Adamson and Bakeman (2006) charted the transition in toddlers' learning of speech and concepts (objects), from spatially co-located to spatially dislocated or displaced, an important milestone in word-concept mapping. In a study of parent-toddler interaction, these researchers found that toddlers of 18-30 months increasingly learned speech that was displaced from the context (that it referred to) with age. In turn, mothers matched their speech about contexts to their toddlers' developing ability to hold words and contexts that were separated in space. The mothers of the younger 18-month-olds used speech that was co-located with its context (e.g., "Where's the ball?" - When the ball was located close by in the same room) far more often than the mothers of the 30-month-olds who tended to use speech that was displaced from the context more often (e.g. "Where's the ball?" in the context of the ball being in the next room).

This developmental transition, when viewed from the perspective of a competent word learner, is not surprising, since eventually, children's learning of words for concrete objects or events takes place when the word is spoken by an adult at some distance from the referent. For example, while a train is passing by on a railway track – the mother might say to her 2.5-year-old child "Look at the train! What does the train do? It goes chuga-chuga-chuga!" In contrast, the mother is more likely to wiggle a hand-held object in proximity to and within her 8-month-old infant's visual field when the infant is just starting to learn word-object relations. Learning about

concrete nouns and their meanings (e.g., a ball) entails gradually learning to pair novel words with novel objects with increasing spatial distance between the two, prior to learning the meanings of abstract nouns (e.g., love). As early as 12 months, infants respond to an adult's speech about hidden objects by looking at, pointing to or approaching the location where the object is hidden, suggesting the beginnings of understanding the words they hear with the absent objects (Osina, Needham, & Saylor, 2020; also Osina et al., 2013). Two-year-olds learn novel words that refer to absent objects just as well as words for objects presented after the words are uttered (Akhtar & Tomasello, 1996).

More importantly, infants also actively attend to and "organize their naming space" in order to learn word-object relations from their mother. If mothers' novel spoken words and object presentations are not spatially co-located (Gogate, Bolzani, & Betancourt, 2006), but are well-timed to co-occur with their hand-held object motions (yet another type of maternal assistance discussed in the next chapter), infants of 6- to 8-months varied greatly in their word-object learning. Only the infants who were able to switch their eye-gaze from their mother to the object learned the word-object relations. They moved their eyes (often accompanied by a head-turn) in the direction of the named object, to accommodate the spatial dislocation between the words that their caregivers spoke and the object they showed. In contrast, the infants who failed to switch gaze in this manner from their mother to the named object failed to learn the word-object relations.

These findings taken together speak to the manner in which space is organized both by caregivers and infants to assist in word learning. At first, until around 18 months, the words infants learn are highly context-bound to ease memory constraints of young infants. As the memory constraints ease with development, toddlers are able to learn words for objects and events that are not present in the immediate scene.

Motor Milestones and Language Use

Infants' language learning draws from their ability to navigate and operate in space in several ways. For example, Iverson (2010) proposed that during the first 18 months of life –

> "…… changes in motor skills [e.g., advances in sitting, walking, and object manipulation] provide infants with a broader and more diverse set of opportunities for acting in the world. These opportunities provide contexts for acquiring, practicing and refining skills that contribute, both directly and indirectly, to the development of communication and language [use]." (p.230)

During the entire period of infancy, infants' increased ability to move and interact with their surroundings in new ways plays a major role in the experiences that enable language including word learning. Researchers have noted that significant motor milestones are relevant to major language milestones because the development of language draws more generally from other domains of development. Thus, for instance, infants who achieved unsupported sitting and independent walking earlier had larger vocabulary sizes and faster rates of vocabulary growth at 16- to 28 months (Oudgenoeg-Paz, Volman & Leseman, 2012).

Around 12 months, infants begin to walk first holding an adult's hand (Iverson, 2010; Lenneberg; 1967) and later independently. Independent walking, a major motor milestone, enables the infant to direct and engage in increased joint attention with an adult by bringing objects of interest to the adult, creating new opportunities for engagement and learning (Adolph & Hoch, 2019). The rhythmic limb movements of walking tend to correspond with the beginnings of first word utterances that typically have repetitive syllables, sound rhythmic (e.g., *mama* and *dada*), and involve rhythmic movements of the speech mechanism (e.g., mouth, vocal chords, and chest wall). Motor development scores at 12 months have been found to positively correlate with word frequency at 16 and 20 months, as well as with vocabulary size at 23 months (Longobardi, Spataro, & Rossi-Arnaud, 2014). As another example of the close correspondence between motor and language milestones, rhythmic arm activity (e.g., hand banging) typically precedes rhythmic babbling of syllables by 2-3 weeks in the first year of life (approximately 28 weeks; Eilers, Oller, Levine, Basinger, Lynch, & Urbano, 1993). In line with these findings, allowing 16-month-olds the hands-on experience to explore and to be messy with substances such as food while sitting in a high chair enables the infants to better learn the distinction between mass nouns (things that cannot be counted, e.g., sand or sugar) and count nouns (things that can be counted, e.g., cookies; Perry, Samuelson, & Burdinie, 2014). These findings, taken together, suggest clearly that typically developing infants' speech and language comprehension inherently draw from their learning to use their own body in space.

Infants' Use of Gestures and First Words

In the early stages of word production, infants often produce gestures or specialized actions with their hands, yet another motor milestone, to express meaning (iconic gestures). At first, the ability to produce these

representational gestures is highly context bound, and is closely tied to infants' ability to produce a word that stands for the object or action performed with that object (Iverson & Goldin-Meadow, 2005). For instance, at first, around 12 months, an infant might bring her hand to her ear only when she sees a phone (the gesture is context bound), to depict a phone with the specific iconic gesture. Around 14 months, the infant might first use the word "hello" to depict the phone. Later, around 20 months and onwards the word 'hello" or another word (e.g., phone) might be used in contexts where the phone is absent from the scene to refer to it - the word is no longer context bound. At some point later in time, the toddler might even use a spoon as a substitute for a phone and pretend to talk into it by holding it by her ear as she would a phone. This progressively flexible usage of gesture and language that becomes decontextualized over time seem to go hand-in-hand, once again, suggesting parallel flexibility in motoric expression and expressive language development.

Pointing and First Words

The pointing gesture is a universally important type of infant action that is also closely tied to vocabulary development. In their second year, when infants are just beginning to express themselves, the pointing gesture often serves as a handy substitute for spoken words to express interest in objects in their immediate environment. As infants learn to move around increasingly, they may point to more distant objects to express their interest in the objects during interaction with a caregiver. Indeed, it has been suggested that pointing in the second year serves an information seeking or interrogative (questioning) function, in response to which, informed caregivers provide appropriate verbal labels for objects (Harris & Lane, 2014; Southgate, Van Maanen, & Csibra, 2007), often observed in infant-adult interactions. Even 12-month-old infants seek information from informed and reliable adults rather than uninformed adults (Bazhydai, Westermann, & Parise, 2020).

It is well established that the pointing gesture is one of the first signs of communicative intent, and infants who point more by the end of their first year tend to also become early talkers. For instance, Brooks and Meltzoff (2008) illustrated that infants' extent of use of the pointing gesture in coordination with following the eye gaze of an adult and looking towards an object predicts vocabulary development during the first two years of life. At 10 to 11 months, infants were made to observe an adult look towards an object in an experimental procedure. Infants' looks were scored for whether or not they looked in the same or different direction as the adult, and whether

or not they pointed at the experimenter during the procedure. Parents of the infants completed the MCDI (Fenson et al., 1994), a vocabulary checklist to report on their infants' receptive and expressive language (including vocabulary), first when their infant was between the ages of 10- to 16 months, and again, after their infant was 16 months of age. Infants who followed the eye-gaze of the experimenter as well as pointed at the experimenter showed faster vocabulary growth, suggesting that the pointing gesture predicts vocabulary development in infants in the first two years. Similarly, at 18 months, infants' pointing gesture predicts their word comprehension (McGillion, Herbert, Pine, Vihman, dePaolis, Keren-Portnoy, & Matthews, 2017).

Infants' pointing appears to be a very salient cue for caregivers to label objects for infants. Thus, infants who point more often to objects typically hear object names more often. Furthermore, caregivers provide more labeling responses to their infants' pointing at objects than to their infants' object-directed vocalizations during naturalistic interactions with their 1-year-olds (Wu & Gros-Louis, 2015). These findings taken together, once again, suggest that infants' actions in space are closely tied to their vocabulary development.

Practical Applications for Teaching Vocabulary

Teaching new words in specific spaces

The link between caregivers' naming of novel objects for infants and toddlers in specific spaces and toddlers' better word learning of novel objects in specific spaces (Samuelson & Smith, 2011) has important implications for best practices in the teaching of vocabulary within early intervention and preschool daycare settings. Teachers could be trained to consistently name novel objects by constraining them to specific spaces rather than move them around the classroom or daycare environment, especially in cases where the toddlers are slow to learn words and until mastery is achieved. In addition, especially when naming objects and actions for novice word learners early on, caregivers could be trained to consistently name these objects in the same physical space until infants achieve mastery with the words (e.g., Roy et al., 2015).

Teaching new words with physical activity

One study has directly applied the knowledge that language learning and motor abilities are correlated to examine precisely which teaching

strategies promote children's word learning. Toumpaniari, Loyens, Mavilidi, and Paas (2015) taught preschool-aged 4-year-old Greek children twenty novel English names for animals (e.g., dog), for one hour per day over a 4-week teaching period. The children were taught the words using one of three different instructional methods - words accompanying physical enactment (e.g., moving like a dog on all fours) and gestures (e.g., panting like a dog), words accompanying gestures (e.g., say the word and pant like a dog), or words with neither gestures nor physical enactment of the words (e.g., repeat the word after the teacher). Children were asked to provide the meaning of the words during subsequent teaching sessions (one hour per week-day), using the same method in which they had been instructed. At the end of the 4-week period, the children were tested for their learning of the words. The children who were taught the words along with the physical enactment and gesture learned the words far better than the children who were taught the words using neither of the two instructional methods. These findings illustrate that relevant activities accompanying novel words promotes word learning. To complement these findings on children's learning, research assessing the body-object interaction rating or BOI (an index of objects and the interaction with body-parts associated with them) of more than 9000 words in the English language, has shown that words with a high BOI rating are "more concrete, more graspable, and more strongly associated with sensory, haptic, and visual experience" than words with a low BOI rating (Pexman et al., 2019).

Summary and Conclusions

The research findings summarized in this chapter illustrate several ways in which caregivers organize the space between their word utterances and the objects or events that the words stand for, to make word learning easier for their infants and toddlers. Other research vividly highlights how infants use the spatial relations between the words they hear and the objects and entities they see in their environment that matches with how caregivers arrange the objects in space during naming for their infants. Next, in this chapter, several illustrations were provided of how infants themselves learn to comprehend as well as produce words for objects or actions by drawing upon their developing ability to move their own body in space. These body movements included infants' achievement of major motor milestones such as the ability to walk, to manipulate objects of different types including countable objects versus substances, and their use of gestures, including representational gestures and pointing, that corresponded with major language milestones including word usage. These various abilities to

maneuver themselves in space "create opportunities for infants" to not only explore their surroundings in new ways, but also "to acquire and refine their abilities in other domains including language" and social interaction (Focaroli & Iverson, 2017).

The maneuverability in space continues to play a role in word learning much later during childhood. Children who are taught novel words in a second language and asked to enact what the words depicted, learned the words better than those who were not asked to enact the words. In short, space matters when infants and children learn language and interact socially with others in the real world. Since toddlers' ability to maneuver themselves in space is directly correlated with their vocabulary development, could caregivers tailor the environment so that infants first encounter words with a high BOI (body-object interaction) rating by using objects associated with those words? For example, a concrete strategy for increasing familiarity with novel words, discussed in Chapter 1, could be to use the words in the infants' and toddlers' presence with greater BOI ratings. Such strategies could be beneficial to infants and young children's vocabulary development, and are likely to enhance vocabulary in children who exhibit delayed vocabulary.

CHAPTER FOUR

TIMING PERCEPTION GUIDES WORD LEARNING

Have you ever watched a mother and her infant play together prior to the infant learning to talk? In particular, have you ever watched a mother playfully interact with her infant and a novel object? A number of timing relations within these playful interactions are of critical importance to infants' language learning. In many cultures around the world, while engaging infants in everyday playful interactions with toys or other objects, mothers typically perform an attention getting action with the object such as moving it towards their infant or shaking the object while naming it at the same time, as if to show the object of interest. For example, Spanish-speaking mothers from Mexico are likely to show or shake a stuffed toy dog in the line of sight of their infant while at the same time saying - Mira! Perro! (Look! Dog!). Similarly, Asian-Indian Hindi speaking mothers are just as likely to perform these actions, but are likely to say – Dékho! Kuta! (Look! Dog!), whereas American-English speaking mothers might say – Look! Doggie! These multisensory mother-infant interactions can inform professionals and other caregivers how to go about facilitating language development in infants by constraining the timing between their word utterances and their showing of objects or actions.

What is the nature of this well-timed multisensory maternal naming, its importance to language learning, and language teaching in everyday environments, where there may be several objects and perhaps even several talkers around infants potentially vying for infants' attention? For the novice word learner (the infant), the tightly coupled, timing overlap or synchrony between spoken words and actions performed with objects highlights or emphasizes the novel relations between specific spoken words and the acted-upon objects or the actions themselves. In addition to the overlap in timing, the moving object and spoken word likely match in their rhythm, tempo, and in their intensity across the visual and auditory senses. This shared or redundant multisensory information is highly salient for infants beginning to make sense of their caregivers' communication (Gogate,

Bahrick & Watson, 2000), because the redundancy recruits infants' attention to the auditory-visual relations (Bahrick & Lickliter, 2000), the spoken word and the moved object.

Novice word learners do not know right from the start which words go with or relate to which specific objects or actions, nor do they know how to go about relating the otherwise unrelated words and objects or actions across the senses on their own. Recall the discussion in Chapter 3, that a large number of words and what they stand for bear no resemblance to one another, are arbitrarily related, and must be learned through experience. Infants, therefore, must rely on their primary caregivers to assist them in learning these arbitrary relations. When communicating with infants and toddlers, the timing overlap between what is said and what is shown makes it easier for them to learn what their mother is naming when other objects are present on the scene. To further simplify the problem space for the novice word learner, mothers' utterances often are limited to a single word or two (see earlier example utterances in three different languages), where the novel word alone co-occurs with the hand-held object's motion. This playful interchange is typically repeated several times in close proximity to the infant and within the infant's visual field to completely engage the infant (Yu & Smith, 2013). Sometimes, the mother might also touch her infant with the object at the same time as she moves and names it. This simple multisensory naming strategy called "multimodal motherese", among many others, helps to initiate infants into the adult's highly complex world of communication (Gogate, et al., 2000). In response to the mother, the infant might orient and attend to the object while smiling, babbling and attempting to grasp and hold the object of shared interest.

In this chapter, I present scientific evidence for infants' learning of word mappings when mothers intuitively speak the words and simultaneously show objects or actions. Next, I present scientific evidence for infants' learning of words for body parts when mothers speak the words while touching the very same body parts. Finally, I present evidence for the overlap in timing of larger chunks of parents' utterances and actions upon objects by parents as well as toddlers that contributes to novel word learning. These findings taken together underscore that the timing overlap or redundancy that infants perceive through hearing, vision and touch is quintessential for word learning.

Redundant Auditory-Visual Relations in Maternal Naming and Infants' Learning of Word-World Relations

In the late 1970s and early 1980s, researchers in the field of developmental psychology first observed that English-speaking British mothers often used closely timed and synchronous words and showed objects during naming for infants during play (Messer, 1978; Harris, Jones & Grant, 1983). Field studies across cultures further corroborated this evidence in mothers from the United States and Mexico (Zukow-Goldring, 1997). Sullivan and Horowitz (1983) first theorized that, during the first year of life, infants' ability to detect these auditory-visual-tactile redundancies plays a key role in their learning to link words to the world when caregivers use overlapping and synchronous words and gestures. E.J. Gibson among others also theorized that the common information across the senses or redundancy, such as the temporal synchrony, common tempo, and rhythm available in caregivers' overlapping word and gesture pairings recruit and educate infants' attention to the relations between words and the world (E. J. Gibson, 1969; also Zukow, 1991). Infants, in turn, are quite adept at detecting redundant information in auditory-visual patterns of stimulation such as between the face and voice of talking persons (see Bahrick & Pickens, 1994).

Whether synchrony between spoken utterances and objects in motion facilitates the learning of arbitrary relations between utterances and moving objects was not experimentally investigated using multiple participants until the late 1990s (Gogate & Bahrick, 1998; 2001). In a series of experimental studies relevant to early noun learning, infants of 7 months were tested for their ability to learn the relations between simple utterances and objects using one of three different video-displays. In the synchronous displays, the vowels 'a' or 'i' were spoken by a female speaker while simultaneously holding and moving a different toy object either forward or diagonally as if showing each object to the infants. In the asynchronous video-displays, the same female speaker spoke the same vowel sounds and moved the same toy object in the same manner. However, the video segments were digitally manipulated so that the timing of the spoken words was out of phase with the moving objects, specifying no relation between them. In the still displays, the same words were spoken when the object remained static, once again specifying no relation between spoken utterance and object motion. Infants were first exposed to one of these types of displays and then tested for their learning of the utterance-object relations. The infants who saw the synchronous but not the asynchronous or the still displays put together the spoken vowel sounds and objects, suggesting that the timing overlap

between utterances and object motion facilitates learning of the novel relations. These findings on temporal synchrony and novel sound-object learning have since been replicated using more complex word-like utterances such as 'tah' and 'gah' (Gogate, 2010) and multisyllabic utterances embedded in whole sentences presented to older infants ranging from 11-22 months (Jesse & Johnson, 2012; 2016; Rader & Zukow-Goldring, 2012), and are relevant to early noun learning.

Of relevance to early verb learning, after repeated exposure to a video of a woman's repeated actions upon an object (e.g., leaning forward and touching a block with her chin), either in the presence or absence of a synchronous spoken word, 6- to 8-month-olds respond to a change in the action but not the object (Chen et al., 2015). Monolingual infants of 8 months learn two word-action relations when synchrony between the words and actions is provided (Gogate & Maganti, 2017). Bilingual infants of 10.5 months learning English and a second language such as Spanish, learn the same two word-action relations, once again, when synchrony between the words and actions is provided (Gogate & Maganti, 2020).

Complementing the findings on synchrony and infants' learning of word-object and -action relations, examinations of mothers' naming have shown that they use a great deal of synchrony during naming of novel objects and actions to infants of ages ranging from 5 to 48 months, relative to other naming styles such as the naming of static objects. In particular, when infants first learn to put together words and objects or actions between 6 to 9 months, mothers from western and non-western cultures often name novel objects or actions (approximately 70% of the time) by highlighting the novel relations using synchrony between the novel spoken words and objects or actions (Gogate, Bahrick, & Watson, 2000; Gogate, Maganti, & Laing, 2013; Gogate, Maganti, & Bahrick, 2015). This naming style recruits novice word learners' attention, because the timing redundancy highlights the relations between the novel words and the novel objects or actions. Mothers do not use this naming style as often when simply using words in passing or when naming familiar objects. In addition, mothers adapt their naming style to their infants' developing ability to learn novel word-object or –action relations on their own. As children become more adept at putting together words and what they stand for, at about 21 months and beyond, maternal use of synchrony during naming decreases (approximately 43%). Their use of other naming styles, such as naming an object when the toddler holds and manipulates it, increases (Gogate et al., 2000; 2015). This evidence suggests a match between maternal naming style and infants' word learning ability.

The Direct Benefits of Teaching Novel Word-World Relations using Synchrony

Although direct evidence relating maternal use of synchronous naming to infants' learning of novel word-object or -action relations is sparse, two studies speak directly to the benefits of teaching infants word-world relations using synchrony, and begin to explain some of the variations in children's rate of word learning in the first two years. In the first study, during a brief interactive play session, Spanish or English learning infants of 6- to 8 months whose mothers used synchronous naming when teaching two novel word-object relations more often learned the word-object relations better than infants of the same age whose mothers did not use this multisensory naming style as often (Gogate, Bolzani & Betancourt, 2006). Gogate et al. (2006) concluded that maternal synchronous naming of objects and infants' perception of synchronous naming bear a bidirectional relation-

> "…. when mothers provided temporal synchrony between otherwise unrelated spoken words and moving objects, the redundant information … captured infants' attention and highlighted the arbitrary relation." (p.281-282).

More recently, a second study longitudinally examined infants from 6- to 24 months and their mothers. Maternal synchronous naming of actions early on during an interactive routine activity of changing diapers was found to be correlated with their toddlers' later verb learning and production. In other words, the 6-month-old infants whose mothers used synchrony when naming actions more often while changing diapers learned and remembered the word-action relations at 17 months better than the infants whose mothers used synchrony to a lesser extent (Nomikou, Koke & Rohlfing, 2017). At 24 months, the former set of infants produced verbs that their mothers had used synchronously with the actions at 6 months, suggesting a robust memory for the word-action relations, assisted by maternal synchrony use. The authors established that–

> "…mothers who coordinate their use of verbs in time with the ongoing actions scaffold their children's verb acquisition by providing them with tangible relationships between verbs and actions to a greater degree than mothers who provide the verb and action ….[timed] apart." (Nomikou et al., 2017, p.14)

These two sets of findings underscore the direct benefits of teaching novice word learners the links between words and the world using well-

timed, synchronous word-object and -action relations during everyday interactions to assist in vocabulary building. In Chapter 3, the benefits of maternal spatial alignment of spoken words and object placement in easing infants' memory load was discussed in detail. Likewise, maternal alignment of the timing between novel spoken words and showing of objects or actions serves to ease the memory load for novice infant word learners and assists in unifying each novel word with its correct referent.

Mothers' Naming Using Simultaneous Touch and Infants' Learning of Word-World Relations

Several studies have reported that caregivers often touch their infants with novel objects while moving them (e.g., Gogate, Bahrick & Watson, 2000; Gogate et al., 2006; Gogate et al., 2015), or more directly with their hands when naming body parts (Abu-Zhaya, Cristia, Seidl, 2016; Seidl et al., 2015; Tincoff et al., 2019) to recruit infants' attention during naming. Such redundant information across tactile, auditory, and visual senses plays a key role in highlighting the otherwise unrelated word and object, and recruits the novice word learner's attention to the name, the specific object, and the relation between them. Gogate et al. (2000) reported that up to 27% of synchronous words and object motions also simultaneously co-occur with touch, when mothers name novel objects. For example, Zukow-Goldring (1997) reported that a Mexican mother tugged on her child's hair while simultaneously saying pelo.

Touch is particularly salient to infants when they learn names for body parts such as hands, feet and knees. Caregivers often use these words when interacting with their infants relative to words that do not refer to body parts (Maouene, Hidaka & Smith, 2008). When infants first hear caregivers' speech, they need assistance segmenting a word from a continuous stream of speech, prior to mapping it to the correct body part. How does the young infant begin to segment a word? Seidl et al. (2015) demonstrated that caregivers' simultaneous touch with word utterances helps infants as young as 4 months to find the boundaries between words that refer to body parts. Building upon this earlier finding on touch facilitating word segmentation, Tincoff and colleagues (2019) found that, during their first year, infants learn nonsense words that caregivers teach as names for the body-parts elbow and knee, if the names are provided simultaneous with caregiver touch to the specific body part (also see Abu-Zhaya et al., 2016). Abu-Zhaya et al. (2016) underscore that both speech and touch are emphasized when the two cues are simultaneous with one another relative to when either cue is presented without the other in caregivers' repertoire. In this manner,

synchronous spoken words and touch of the body part helps infants to not only find the word in the speech stream but also to map it to the correct body part. But how does simultaneous touch facilitate infants' learning of the larger body of words that do not refer to body parts? Dueker, Portko, & Zelinsky (2011) found that when caregivers discuss concrete topics to infants, such as when naming tangible objects they tend to use less touch relative to when they discuss abstract topics such as their feelings (e.g., love, or sadness). In this manner, touch plays an important role in infants' learning of concrete and abstract words and in caregivers' teaching of novel words to infants in the first year of life.

The Bidirectional Relation between Caregiver Communication and Infant Word Learning

Several studies reviewed in the prior sections of the present chapter have implied a unidirectional transfer of knowledge from the caregiver, the language expert, to the infant or toddler, the novice word learner. However, some studies suggest that toddlers as well as young infants are actively engaged in altering their caregivers' behaviors in naming contexts, just as caregivers' naming behavior influences infants' word-world relation learning. Thus, I emphasize here that vocabulary learning is a collaborative or interactive process that entails infants' adapting to caregivers' communication and caregivers' adapting to the infants' ability to learn words.

For example, prior research has shown that older infants (toddlers) actively initiate interactions with their caregivers. Specifically, in naming contexts, caregivers are likely to name objects that their toddlers are already attending to and exploring manually (Akhtar, Dunham & Dunham, 1991; Gogate et al., 2000; 2015; Tamis-LeMonda, Bornstein, & Baumwell, 2001). This type of naming, although contingent and embedded in a social interaction, no longer requires tightly-coupled synchrony between the caregiver's spoken word and motion of an object of interest for word learning to take place. Researchers have suggested that this type of contingent naming during social interaction also facilitates learning of word-world links. For instance, Tamis-Lemonda and colleagues (2014) underscore three specific characteristics of caregiver responsive behaviors that facilitate novel word learning in infants-

> "First, responsive behaviors are contiguous (temporally connected) and contingent (conceptually dependent) on infant actions. Second, responsive behaviors are didactic (informative) and embodied

> (multimodal). And third, responsive behaviors are attuned to and scaffold infants' development. Collectively, these features of responsiveness provide a perspective of language development …." (Tamis-Lemonda, Kuchirko, & Song, 2014, p.123).

When mothers name objects that infants are already visually attending to and manipulating, as was found earlier by Akhtar and colleagues (1991), maternal responses to infants' actions become connected in time, informative to language learners, and multimodal; they are also attuned to and scaffold or support infants' language development. However, Baron-Cohen, Baldwin and Crowson (1997) found that even at 24 months, toddlers learned novel word-object mappings by following the adult speaker's direction of gaze toward the novel object, not their own direction of gaze to an object in hand.

More recent studies show that very young infants' (not just toddlers') behaviors in naming contexts also influence caregivers' naming behavior. For example, Chang, de Barbaro, and Deák (2016) examined mothers and infants at play from the time infants were 4 months of age until they were 9 months of age. They reported that mothers labeled objects more often when their infants vocalized, looked at the objects of interest or the mother's face, or manually explored multiple objects of interest. As infants became older, their object exploration duration increased and created many opportunities for mothers to name objects contingently, and changed how mothers looked at or examined the objects they named over time. Indeed mothers are highly responsive to their infants' level of skill in performing task relevant actions. Therefore, when infants demonstrate cup nesting behaviors at ages 11-13 months, their mothers demonstrate cup nesting behaviors far more often than when infants simply bang on objects at an earlier age (around 6 months; Fukuyama, Qin, Kanakogi, Nagai, Asada, & Myowa-Yamakoshi, 2014).

Infants' behavior also influences the type of mothers' physical and brain responses by altering their detection of the timing overlap between their spoken words and object touches. For instance, Tanaka, Fukushima, Okanoya, and Myowa-Yamakoshi (2014) have reported that daily interactions between mothers and infants enhance the detection of multisensory information in mothers' brains in parenting contexts. Mothers' versus female non-mothers' brain-wave activity was examined experimentally when they were presented with temporally synchronous versus non-synchronous auditory-tactile naming displays in adult-directed versus infant-directed speech. Unlike the female non-mothers' brains, the mothers' brains differentiated and detected the greater timing offset or mismatch between the spoken words and asynchronously touched objects when presented in infant-directed speech. Daily maternal interaction with

infants, including maternal object naming using synchrony between spoken words and object touch strengthens the neuronal connections in mothers' brains in response to the multimodal events. These findings underscore the bidirectional interactions between mothers and their infants, and illustrate that infants' behavior influences mothers' responses to the timing overlap between spoken words and object touches.

Broader Synchronies in Caregiver-Infant Interaction

Thus far, in this section, the timing overlap between words and objects or words and actions in maternal communication and infants' ability to glean these relations by detecting the overlap in timing has been addressed. It is important to note, however, that overlaps in timing have also been observed at broader or more expanded levels of discourse in maternal interaction with their infants in addition to word-object and -action synchrony. For example, Brand and colleagues have shown that during mother-infant interaction, mothers often talk while performing exaggerated actions. The temporal overlap between the actions and maternal speech, called motionese, captures infants' attention to the ongoing action, and packages the otherwise incoherent speech stream into coherent units, making it easier for the novice learner to learn language (Brand, Baldwin & Ashburn, 2002; Brand & Tapscott, 2007; Meyer, Hard, Brand, McGarvey, & Baldwin, 2011). Similarly, Suanda, Smith and Yu (2016) compared mothers' extended discourse where they presented, named and discussed a novel object across multiple sentences with their toddlers of approximately 18 months during free-play episodes. Using head-mounted mini-video cameras, located on the toddlers' and the parents' head, that was embedded in a headband and close to the eyes of each participant, they observed the toddlers' as well as the parents' first-person view of the object during toddler-parent interaction. They found that extended parental discourse about the target object co-occurred predominantly with that object being dominant in the toddlers' visual field relative to other objects on the scene, a visible parental action upon that object, or the toddler touching the object of interest. These different non-verbal cues when coupled with parents' verbal discourse provided a rich multisensory context during which toddlers were provided ample opportunities to learn the name the parent gave to the novel object (also see Suanda, Barnhart, Smith, & Yu, 2018).

In a recent study of 8- to 10-month-old infants, the learning of grammatical rules such as word order was facilitated when infants were presented with semantically congruent talking faces and syllables that were temporally synchronous (Tseng, Chow, Yuen, & Ding, 2018). In contrast,

presenting the same faces with incongruent beeps in temporal synchrony did not have the same facilitative effect on learning the grammatical rules, suggesting that temporal synchrony matters to infants at 8- to 10-months of age, provided that other expectations about communication are met, such as a person speaking and simultaneously vocalizing matching syllables.

Harrist and Waugh (2002) have suggested even more broadly, that the smooth and harmonious flow or "synchrony" during dyadic (two-way) interaction between infant/child and caregiver, when it is relatively well-matched to children's level of development, leads to the attainment of age-appropriate developmental milestones in children in the first few years of life. Leclère, Viaux, Avril, Achard, Chetouani, et al. (2014) also underscore the importance of this type of broader flow or synchrony in everyday maternal-infant interactions for language development. An example of this type of broader synchrony is the harmonious and smooth turn-taking between caregivers and children during conversations that is known to play a quintessential role in communicative development, and in particular, in facilitating vocabulary learning (Perry, Prince, Valtierra, Rivero-Fernandez, Ullery, et al., 2018).

Summary and Conclusions

The scientific evidence clearly illustrates that infants learn word-world mappings when mothers intuitively speak the words and simultaneously show objects or demonstrate actions. Furthermore, the scientific evidence illustrates that infants learn words for body parts when mothers speak the words while touching those body parts. Finally, the evidence suggests that overlap in timing of larger chunks of parents' utterances and actions upon objects by parents as well as toddlers contributes to novel word learning, and synchronous faces and voices even aid in infants' abstraction of rules such as word order (grammar) in sentences. These findings taken together underscore that timing matters and organizes what and how infants perceive to be relevant, language-like information through their senses. Perception of redundant multisensory information – information that is presented simultaneously across hearing, vision and touch is not only quintessential for word learning but is essential for the understanding of communication as a whole.

This body of converging evidence on timing overlap provides a broad rubric for teaching infants, toddlers and children about word-world links as well as larger chunks of meaning. Fairly early in the language learning phase, caregivers could manipulate the timing overlap between various units of speech (e.g., individual words or entire phrases), visual patterns of

stimulation and touch to enhance language development. Infants' attention to novel word-world links can be heightened by using such timing overlap to mitigate vocabulary delays in the first and second years. At the same time, after monitoring caregiver-infant interactions in the home and in daycare settings, if the temporal overlap is found to be absent or minimal in caregivers' communication to infants and toddlers, the caregivers could be trained to use such timing overlap at optimal levels as a means to encourage greater word learning in their infants and toddlers.

CHAPTER FIVE

CAREGIVERS' GESTURE AND TOUCH GUIDE WORD LEARNING

Learning words and their meanings clearly involves attending to much more than just the sounds that make up the words. The previous chapter (Chapter 4) addressed in detail how infants and young children learn words by attending to caregivers' use of simultaneous auditory, visual and tactile cues. Adults' specific actions upon objects such as rolling versus squeezing educate toddlers about the shapes of the specific objects and the substances of which they are made (e.g., a rigid object made of steel versus a spongy object; Kobayashi, 1997). The relation between infants' and toddlers' action perception, word comprehension as well as production is also well established (Kaduk, Bakker, Javrud, Gredebäck, Westermann, Lunn, & Reid, 2016). What specific types of exaggerated bodily gestures or stylized actions as well as touch do caregivers provide during naming that assist infants' ability to learn words?

Among the many visual cues that caregivers provide for their infants during naming are gestures with their hands that draw infants' attention to things in the world such as objects of interest or activities in the immediate environment. For instance, as discussed in the previous chapter, when mothers name objects for their 6- to 8-month-olds in naturalistic interactions, they often shake or rotate a hand-held object of interest while naming it (e.g., Gogate, Maganti, & Laing, 2013), or might point to a static object on the scene. These gestures enhance the communicative nature of their interaction and draw infants' attention to novel objects. Gestures, therefore, are meaningful movements to infants and children. In fact, gesture and language comprehension share common brain mechanisms (regions) in infants. Therefore, younger infants accept gestures as well as words as labels for objects, whereas older toddlers accept only words but not gestures as labels for the objects (Namy, & Waxman, 1998). In the present chapter, exactly how caregivers' gestures and touch influence infants' word learning will be examined in detail. Furthermore, how

caregivers' pointing gestures towards an object or event of interest facilitate early word learning by infants will be discussed at length.

Exaggerated Maternal Gestures and Touch in Mother-Infant Interaction

Chapter 2 illustrated how the exaggerated nature of caregivers' child-directed speech relative to adult-directed speech facilitates many facets of word learning. Often accompanying the exaggerated speech, caregivers provide exaggerated gestures when communicating with their infants and young children. For example, mothers often exaggerate their finger movements while showing their infants how to manipulate objects. Nagata, Yamamoto, Matsuda, and Hiraki (2018) asked mothers to demonstrate actions upon a toy object for their young child of 24 to 34 months, an adult family member who did not know how to use the toy, and an adult female stranger who knew how to use the toy. During interaction with their children, the mothers' finger movements around the object were far more exaggerated when compared to the mothers' interaction with the adult family member. Although the exaggerated actions were demonstrations upon objects, they were not simply movements for movement's sake. To the contrary, they served a communicative function of educating their infant or child on how to manipulate an object.

Maternal exaggerated actions with their hands are not only simultaneous with isolated words but are also simultaneous with whole clauses or phrases and contain exaggerated pauses between them called *motionese* (Brand et al., 2002; Brand & Tapscott, 2007). Eye-tracking studies of toddlers suggest that they are drawn to these exaggerated action and simultaneous speech sequences (Suanda, Smith, & Yu, 2017). Furthermore, a recent examination of the extent of these maternal stylized action sequences accompanying speech showed that they are negatively correlated with a maternal report of their young children's vocabulary (George, Bulgarelli, Roe, & Weiss, 2019). In other words, mothers use these gesture-speech sequences more often to children, between 2.5-5 years, who have fewer spoken words in their vocabulary relative to children who have a greater command of their vocabulary. The exaggerated maternal gesture sequences upon objects during play interactions and their simultaneous commentary about those action sequences enable infants to detect and segment clausal or phrasal boundaries of sentences that might otherwise remain ambiguous to young infants (Suanda et al., 2017). In summary, maternal ability to highlight clausal and phrasal boundaries by using exaggerated action sequences that are synchronous with exaggerated speech

sequences serves to educate young children's attention to the event sequences as well as the clausal or phrasal boundaries.

As another example of gestures, during interactions with their infants, mothers use exaggerated head movements more often than during interactions with an adult (Smith & Strader, 2014). To reiterate, the exaggerated head movements are not simply actions for their own sake. Rather, these gestures serve a specific purpose of highlighting aspects of communication for infants who are novices to these aspects of communication (Novack & Goldin-Meadow, 2017). Taken along with exaggerated speech, the specialized gestures serve to highlight word-object or word-action relations, the meanings of clauses or phrases, and help to segment the stream of speech into lexical, phrasal or clausal boundaries. One possible underlying explanation for the exaggerated hand and head movements (gestures) during object demonstration as well as continuous speech to infants (discussed in Chapter 2), is that while interacting with their infants or young children, mothers show heightened emotional states or arousal (Yoshida, Smith, Ping, & Davis, 2002). Such heightened arousal in mothers results in their greater use of unique types of gesturing simultaneous with exaggerated speech.

Does greater maternal arousal during interaction with their infants also result in greater amounts of touching infants simultaneous with speech? This specific question is yet to be answered. However, one study has shown that when words refer to body parts that cannot be separated in the real world from the whole (e.g., words such as *knee* and *elbow*), infants of 4 months learned to separate the words better from a continuous speech stream, if an experimenter (adult) touched the infants while simultaneously naming the body parts. In contrast, when the same words were not simultaneous with touch, the infants did not segment the words from the speech stream (Seidl, Tincoff, Baker, & Cristia, 2015). The authors suggested that greater maternal touching of their infants while naming body parts likely assists infants to detect word boundaries, and could explain, in part, why infants learn the meanings of body-part words earlier than other words (Tincoff & Jusczyk, 2012).

Gestures, Touch, and Word-Mapping

When naming novel objects for their infants in the first year, mothers often use specific types of showing motions or gestures. These showing motions highlight the novel word-object relations for young infants who likely require this type of highlighting to learn the relations. For example, mothers often use shaking and looming hand-held object motions, while naming novel objects in isolation or embedding the object names in simple

sentences to their 6- to 8-month-old infants, relative to upwards, sideways or backwards motions (Matatyaho & Gogate, 2008). Reciprocally, in infant experiments, 8-month-olds map words onto objects easily when an adult uses the same shaking or looming object motions simultaneous with their object naming, but not when the adult uses sideways, upward or backward motions simultaneous with their object naming (Matatyaho, Mason, & Gogate, 2007; Matatyaho-Bullaro, Gogate, Mason, Cadavid, & Abdel-Mottaleb, 2014). As early as 6- to 8-months, infants attend to the salient showing gestures accompanying novel words in isolation and when embedded in whole sentences (Matatyaho & Gogate, 2008). In another study, infants of 9- to 14 months looked longer at an object when an adult used a dynamic action upon the object simultaneous with a novel spoken word embedded in a complete sentence (Rader & Zukow-Goldring, 2010) versus when the adult used the same actions but not simultaneous with the spoken word. Based on these findings, the authors suggested that adults use their hands and strategically time their gestures to control infants' attention to word learning contexts. Caregivers use single word utterances more often to young infants and gradually increase their speech complexity to multiword utterances. Reciprocally, infants learn words better when words are presented in isolation in their first year and only later learn words in multiword utterances (Keren-Portnoy, Vihman, & Fisher, 2018).

In addition to the specific gestures that facilitate word-object and –action mapping, caregivers' gestures often result in touching their infant with the novel object. For example, mothers highlight word-referent relations by using synchronous spoken words and object motions, and simultaneously touching their infants more often when using novel words (17%) than when using other words in passing (6%, Gogate, Bahrick & Watson, 2000; Gogate, Bolzani, & Betancourt, 2006). In specific reference to infants' learning of words for body parts, caregiver touch plays a unique and important role in facilitating infants' ability to put words and body parts together. For instance, in a recent study, mothers of 4-5 and 10-11 month-old infants were asked to teach nonsense words that referred to body parts. Mothers spontaneously touched their infant's specific body parts while simultaneously saying the word that they taught to their infants (Tincoff, Seidl, Buckley, Wojcik, & Cristia, 2019). An important question that emerges from these findings is whether maternal gestures or touch elicit greater infant attention or whether infant attention to the mother elicits greater use of maternal gestures, touch and speech.

A further study provides cross-cultural evidence for reciprocity between maternal gestures and infants' attention to them leading to language understanding. Infants starting at around 6 months from Asian-

Indian homes learn, understand, and comply with parental gestures involving objects that depict actions such as 'give' and 'take' (Reddy, Liebal, Hicks, Jonnalgadda, & Chintalapuri, 2013). The compliance suggests that these infants begin to comprehend verbs fairly early, and that maternal gestures serve an important means for such verb learning. However, there are cultural variations in both maternal gesture use and infants' compliance of directives using the gestures. In their longitudinal study of infants, from 6.5- to 12.5-months, and their mothers, Reddy et al. (2013) found that British-English mothers used fewer directive gestures depicting verbs of compliance (e.g., give and take) than the Asian-Indian mothers (who spoke Telugu) while interacting with their infants. Reciprocally, the British-English infants showed less compliance relative to the Asian-Indian infants. The findings suggest a direct relation between maternal gesture use to their infants and infants' understanding of the directive gestures and the verbs they depict across cultures. Complementing these findings, greater gesture perception at 9 months is related to greater language comprehension at 9 and 18 months (Kaduk et al., 2016).

The following set of studies suggests that not only is greater maternal gesture use associated with greater infant verb learning, but that infants' greater attention and actions elicit greater maternal actions or gestures that are simultaneous with speech. For example, during mother-infant everyday interactions (e.g., changing diapers), for infants around 6 months of age, mothers often gesture while simultaneously using verbs when the infants look at their mothers or act upon objects, rather than when infants look away from their mothers or are inactive. Greater simultaneous use of maternal gestures and verb production is, in turn, positively associated with greater infant verb learning in the second year (Nomikou, Koke, & Rohlfing, 2017). Similarly, during interactions with their mother, infants' increased gaze toward their mother and increased manipulation of multiple objects, between 4 and 9 months, elicited a greater number of maternal object names and appropriately timed gestures using the objects (Chang, Barbaro & Deák, 2016). Whether infants drive greater maternal gesture use or mothers' greater gesture use elicits increased infant attention, the findings, taken together, provide strong evidence for a highly interactive process at play, where infants' actions (gaze and actions upon objects on the scene) elicit caregiver action/gesture use and contingent words that contribute, in turn, to infants' noun-object and verb-action relation learning and increased word comprehension.

Caregivers' Iconic Gestures and Infant Word Learning

One means by which children learn to make iconic gestures as well as learn about the meanings of words is by imitating caregivers' iconic gestures (Novack, Goldin-Meadow, & Woodward, 2015). Iconic gestures are gestures that resemble and depict the meaning of a word (e.g., holding one's palm flat on one's ear to depict a phone, or making a panting noise with the tongue hanging out to depict a dog, Goodwyn, Acredolo, & Brown, 2000, or stretching an arm out with an open palm to depict "give" while looking at an adult who might be holding an object of interest). Toddlers typically learn and use iconic gestures to depict objects or actions prior to learning the words that stand for them (Goldin-Meadow, 2020).

Older 3-year-olds comprehend iconic gestures better than younger 2-year-old children. Novack et al. (2015) examined whether 2- and 3-year-olds could comprehend an iconic gesture and use it to learn a new action upon a specific target object. The children were shown an iconic gesture that involved pretending to put a ring on a post (without actually touching the ring or post), or no gesture at all, or an incomplete gesture (failed attempt at putting the ring on the post) while the adult looked at the children. Children of both ages learned and performed the target action better when they were shown the iconic gesture relative to no gesture at all. However, the 2-year-olds learned the target action better when they were shown an incomplete gesture relative to the iconic gesture. The authors suggested, based on these findings, that the 2-year-olds are as yet unable to comprehend iconic gestures as well as 3-year-olds.

Several others have shown, however, that when caregivers present iconic gestures simultaneous with words, they facilitate early learning of word-action relations and may well form the basis for the learning of verbs, adjectives, and adverbs early on across cultures (e.g., Imai, Kita, Nagumo, & Okada, 2008; Yoshida, 2012; see review by Imai, & Kita., 2014). For example, Yoshida (2012) illustrated that, relative to English speaking mothers, Japanese mothers use many more words whose sounds resemble the gestures to which they refer (e.g., dondon suru refers to a jumping motion and kurukuru suru refers to a circular motion), and that 2-year-olds from both cultures benefit from such sound-gesture correspondences during verb learning. Similarly, 3-year-old Japanese learning children learned to map words onto gestures easier if the gestures physically resembled what the word sounded like or were sound-symbolic in nature when compared to gestures that bore no physical resemblance to what the word stood for (Imai et al., 2008).

Caregiver Pointing and Infant Word Learning

Parents use the pointing gesture often during interactions with their children and these gestures often co-occur with speech (e.g., Acredolo & Goodwyn, 1988). For the most part, these gestures emphasize the message that caregivers convey in their speech. For instance, they might point to a flying bird while saying "Look, birdie!" (Iverson, Capirci, Longobardi, & Caselli, 1999; Özçalişkan & Goldin-Meadow, 2005). Complementing the findings on caregivers' use of the pointing gesture, infants in their first year expect the pointing gesture of adults to go with their speech. As a case in point, 9-month-old infants from a Catalan learning environment in Spain were able to detect that a pointing gesture is timed with the stressed syllable of a novel word (Esteve-Gibert, Pons, & Prieto, 2015). This finding suggests that by 9 months, infants not only expect gestures to co-occur with speech, but also to go with the stressed syllable rather than the unstressed one of a word. By the end of their first year, infants implicitly know that caregivers' gestures hold communicative intent. Thus, by 12 months, infants come to expect that a point followed by an excited expression such as "ah" to a curtain covering a door should result in something exciting such as a toy object when the door is opened, rather than an empty table (Pätzold, & Liszkowski, 2019). In contrast, 8-month-olds, given the same pointing and excited expression, do not indicate that they expect something exciting on the other side of the closed door. These findings clearly suggest that the implicit knowledge that caregivers' gestures and simultaneous speech hold communicative intent develops between 8 and 12 months of age. The expectations speak to infants' developing understanding of communicative cues. These findings are consistent with prior findings illustrating that by 12 months, infants clearly understand the pointing gesture of their caregivers and other adults (e.g., Carpenter, Nagell, & Tomasello, 1998).

Caregiver pointing and children's comprehension of pointing share a bidirectional relation. Thus, caregivers who use gestures including pointing more often tend to have children who also use gestures more often when communicating. Similarly, caregivers who use gestures early on for their children also have children who begin to use gestures early in their second year (Rowe, Özçalişkan, & Goldin-Meadow, 2008). Children's gesture use at 14 months is positively correlated with their vocabulary at 42 months as observed on a maternal vocabulary checklist. Therefore, caregivers' gesture use indirectly promotes children's gesture use which, in turn, assists children in learning words. An earlier study as well showed that the extent of caregivers' gesture use, including pointing, and speech is positively

associated with toddlers' vocabulary at 16 and 20 months (Iverson et al., 1999).

Conclusions and Applications in Educational/Clinical Settings

Caregivers use a variety of gestures to infants and young children that facilitate early word learning. They use exaggerated finger, hand and head movements during object demonstration that is often accompanied with speech to highlight the relations between the objects and the words. One possible underlying explanation for the exaggerated hand and head movements (gestures) during object demonstration as well as continuous speech to infants (discussed in Chapter 2), is that while interacting with their infants or young children, mothers show greater arousal (Yoshida et al., 2002). This greater arousal in mothers results in greater and unique types of gesturing simultaneous with speech. This was found to be the case with iconic gestures that mimic the meanings of words (Yoshida et al., 2002; also see Goodwyn, Acredolo, & Brown, 2000). Exaggerated maternal gestures or infant-directed action are positively associated with greater infant attention, greater object manipulation (Koterba & Iverson, 2009), and gesture use (Rowe et al. 2008). In turn, greater gesture use by children, including pointing, a prelinguistic form of communication, forms a building block for early language development (Tomasello, Carpenter, & Lizkowski, 2007; Rowe et al., 2008). In addition, greater action perception in 9-month-olds is related to greater language skills at 9 and at 18 months (Kaduk et al., 2016).

More importantly, parental gestures and infants' word learning adapt to one another. Thus, mothers use looming and shaking actions simultaneous with object names to highlight label-object relations for 6- to 8-month-olds (Matatyaho & Gogate, 2008). Reciprocally, infants of 8 months learn the label-object relations best from an adult when, in experiments, novel objects are held and moved, one at a time, using looming or shaking actions (Matatyaho-Bullaro et al., 2014). Furthermore, we see evidence for an adaptive relation between infants' and parents' actions. For example, infants' increased actions during a nesting cup activity with the parent make the parents accordingly adapt and match their actions to their infants' actions during interactions (Fukuyama, Qin, Kanakogi, Nagai, Asada, & Myowa-Yamakoshi, 2014). Reciprocally, parents' gesture variations and speech systematically relate to the extent of toddler's attention (see Chapter 6), object exploration (Koterba & Iverson, 2009), gesture variations (Rowe et al., 2008) and vocabulary (Tomasello et al., 2008).

Finally, infants' understanding of an adult's gesture and subsequent gesture use typically appear spontaneously preceding their language understanding and use. The absence of gesture understanding and use during development should therefore, "raise a clinical red flag" (Goldin-Meadow, 2020). Additionally, given the positive correlation between maternal exaggerated gesture use leading to greater gesture use and vocabulary in children in typical cases, clinicians might recommend, in cases of children with language delays, that parents increase their quantity and quality of gesture use to elicit greater attention and language learning in their child. Simultaneously, children could be trained to use gestures as a means to greater vocabulary learning, rather than the traditional current practice among speech therapists to discourage gesture use to encourage speech.

CHAPTER SIX

JOINT ATTENTION AND WORD LEARNING

The previous chapters in this volume established the importance of everyday social interactions between caregivers and infants and showed how they are quintessential to word learning. For example, at 5- to 6 months and at 9- to 10 months, infants learn novel word-object relations from sentences spoken by a live tutor in a natural manner but not from a televised tutor (Hakuno, Omori, Yamamoto, & Minagawa, 2017), suggesting that adults' live interactions are critical for infants to jointly attend to word learning contexts in which adults often label objects or actions of interest for their infants. Joint or shared attention comprises many different general abilities and processes such as perception, learning, and memory that unite caregivers' and infants' attention to a common point of reference, typically to novel objects or activities, during social interaction; it is not a single process (Siposova & Carpenter, 2019; Yurovsky & Frank, 2017).

Joint attention can be broadly categorized into two types – parent-directed and child- or infant-directed joint attention. During infants' first year of life, joint or coordinated attention to an object during everyday interactions is driven largely by parents' attention to an object and parents' actions upon that object to recruit infants' attention (as discussed in Chapter 5), called *parent-directed joint attention*. Joint attention emerges, in part, from infants' developing ability to attend closely in time to the parent, and an object that the parent displays for her infant (Chapters 4 and 5, this volume). Broadly speaking, this ability to attend closely in time to the parent and an object, in turn, entails that infants develop two abilities that engage their perceptual-motor systems, the ability to switch their own eye-gaze from their parent to the object of common interest (Gogate et al., 2006), and the ability to follow their parent's eye-gaze to an object (Morales, Mundy, & Rojas, 1998; Yu & Smith, 2016) which the parent likely names.

In addition to parent-directed joint attention, parents and infants engage in a second type of joint attention, where infants and toddlers initiate and drive their caregivers' attention during interactions with them, called *child-directed joint attention*. For example, the infant explores an object of interest and then draws the caregiver's attention to it, for which the caregiver

often provides a name (Akhtar, Dunham, & Dunham, 1991; Rollins, 2003), hence referred to as symbol-infused joint attention (Adamson, Bakeman, & Deckner, 2004). Infants are able to elicit their caregiver's attention through their developing vocalizations (e.g., babbling or words) and/or gesture or pointing, or simply by switching eye-gaze from the parent to the object of interest. Subsequently, the parent simply follows their infant's eye-gaze or gestures to the object of now, common interest. In the remaining sections of the present chapter, I will first briefly discuss how joint attention develops in the first year. Next, I will describe both parent-directed and child-directed joint attention in detail in that order, and their specific relation to early word learning.

The Development of Joint Attention

How does joint attention develop during infancy? Infants' attention to objects and their parents during interactions is dynamic and changes over the course of the first year from being largely parent-driven to predominantly child-driven interactions. To explain this developmental process more precisely, longitudinal studies have illustrated that caregiver-directed joint attention precedes infant-directed joint attention in the first year (Carpenter, Nagell, & Tomasello, 1998; de Barbaro, Johnson, Forster, & Deák, 2016). For example, de Barbaro et al. (2016) illustrated that, at 4 months, infants predominantly looked at and manipulated a single object that was held by their mothers. At 6 and 9 months, infants increasingly distributed their attention between mother-held objects and the objects they themselves held and manipulated. Similar findings were reported in prior cross-sectional studies of mother-child interaction, where infants predominantly looked at mothers' actions upon objects during naming between 6 and 8 months, but at 21-30 months mothers increasingly named the objects that infants held and manipulated (Gogate et al., 2000). De Barbaro et al. (2016) also found that, at 12 months, the infants increasingly differentiated between looking at the objects they held versus the objects their parents held. During the entire time period from 4- to 12 months, infants also increasingly separated their visual and haptic (touch) explorations. According to de Barbaro et al. (2016), this ability to separate and increasingly distribute their object exploration between the visual and haptic senses, which allows for the differentiation between self-held and mother-held objects, leads to the development of coordinated joint attention episodes during infant-caregiver interactions.

Caregiver-Directed Joint Attention and Word Learning

As emphasized earlier, a predominant characteristic of early joint attention episodes in the first year is that it is initiated and directed by the adult primary caregiver when she interacts with her infant and potentially names an object. One plausible reason for this adult-initiation is that whereas the expert caregivers are well versed in their ability to communicate and attend to two entities, the infant and a novel object, simultaneously or closely in time, the novice infants are still developing the capacity to attend to two entities, in this case, the mother and a novel object, simultaneously or closely in time. The development of the ability to attend to the two entities, in part, depends on infants' ability to turn their head (and eyes) away from their parent and in the direction of the object that she shows her infant.

A cursory review of the literature suggests that there are three component abilities that make up caregiver-directed joint attention episodes in the first year – (a) caregivers' ability to recruit their infants' attention to an object of interest through manual actions as well as through their eye-gaze, (b) infants' increasing ability to switch their gaze from their mother to the object of interest that she holds in her hand, and (c) infants' ability to attend to that object for a sustained period of time during joint attention episodes. These three abilities discussed below, in turn, predict infants' word learning in the first and second years.

Maternal recruitment of infants' attention to objects of interest

Gredebäck, Fikke, and Melinder (2010) have provided the earliest evidence for maternally-directed joint attention, where mothers look at an object of interest and infants follow their gaze to that object. They showed that 2- to 8-month-old infants follow their mother's or a stranger's eye-gaze during interaction. They assessed infants' and mothers' or strangers' gaze using eye-tracking technology. Infants' gaze following emerged between 2 and 4 months and stabilized between 6 and 8 months of age. Surprisingly, however, the infants showed a stranger (novelty) preference - following the gaze of a stranger more than they followed the gaze of their mother - that emerged between 4 and 6 months of age.

Mothers also recruit their infants' attention to an object of interest via their manual actions upon the object. In a study of 3- to 11-month-old infants and their mothers engaging in object play, maternal manual actions upon the objects combined with verbalizations (i.e., naming and speaking about the object they manipulated) predominantly drove infants' attention

to the novel object (Deák, Krasno, Jasso, & Triesch, 2017). Contrary to the findings of Gredebäck et al. (2010), Deák et al. (2017) found that mothers' gaze alone in the absence of object manipulation or verbalization rarely directed the infants' attention to the novel object during play. In contrast, when mothers looked at an object, manipulated it, and verbalized about the object, infants of ages 3- to 8 months followed their mothers more often to the specific object to which she attended, suggesting once again, that mothers directed their infants' attention with their actions, rather than the infants' directing their mothers' attention to an object of interest.

Infants' developing ability to follow maternal gaze towards an object of interest has been linked directly to infants' word learning and vocabulary development (Bruner, 1983). For example, Morales, Mundy and Rojas (1998) reported that 6-month-old infants who followed their mother's eye-gaze toward a novel object of interest during interaction also understood more words at 24 months, illustrating the direct link between joint attention and later word learning abilities. Similarly, after observing a set of infants during the first two years, Brooks and Meltzoff (2008) found that the infants' ability to follow the eye-gaze (and pointing) of an adult predicted their accelerated word learning and vocabulary growth throughout the first two years of life.

Infants' gaze switching and early word mapping

Maternal actions upon objects during naming also provide ample opportunities, during the first year, for infants to engage in joint attention, by switching their gaze from their mother to the object she holds. As an example, during mother-infant play interactions, American mothers (Caucasian or Hispanic), who were asked to teach the names of two novel objects to their infants, often named a novel object while moving it and showing it to their 6- to 8-month-old preverbal infants. During these naming episodes, the infants who spontaneously switched their eye-gaze from their mother to the novel object more often also learned the names for the objects, as was observed on a subsequent word learning test (Gogate et al., 2006). In contrast, the 6- to 8-month-olds who did not switch gaze from their mother to the object during her naming, failed to learn the two word-object relations. Similarly, older infants of 12 months of age engage in joint attention with the parent by switching their eye-gaze to their hand when the parent manipulates an object of interest (Yu & Smith, 2013). The parent's hand when holding the object of interest looms large in the infants' visual field. Therefore, Yu and Smith (2013) have suggested that infants' ability to engage in joint attention can occur by simply attending to the object that

the parent manipulates in their visual field without the need to follow the parent's gaze. However, Deák, Krasno, Triesch, Lewis, and Sepeta (2014) found that to achieve joint attention during interactions, infants' use their caregiver's hand that holds and manipulates an object of interest, to follow the caregiver's gaze to the object. This finding links the caregivers' manual actions upon objects to infants' gaze following during joint attention episodes.

Maternal object manipulation, gaze and infants' sustained attention

As was discussed earlier, maternal actions upon an object, naming, and other types of verbalization direct their preverbal infants' attention to objects during play interactions, and enable infants to switch their gaze from their mother to the object of common interest. These same maternal behaviors also sustain infants' attention for long periods of time. Thus, it is not surprising that during mother-infant play interaction, the most attention sharing time occurred when the infants followed their mother to whatever she was doing and saying (Deák et al., 2017).

Of importance here is that maternal looks to a novel object of interest directs and sustains infants' attention to the specific object among other objects (Yu & Smith, 2013). Yu and Smith (2016) recorded moment-by-moment eye-gaze during play interactions between parents and their 12-month-old infants. They used eye-tracking, where mini-video cameras, held by a cloth headband, were placed on the parents' and the infants' head to record their eye movements during interactions with a set of toys. The authors reported that when the parents looked at a novel object, their looks directed their infants to look at the same object, and that infants engaged in sustained attention to a novel object only after their parent looked at that novel object during interaction. Recent evidence points to the key role of infants' sustained attention in their word learning. It suggests that although caregivers' attention soliciting ability and infants' ability to switch their gaze from their caregiver to the object of common interest play an important role in word learning, at 9 months, it is the infants' ability for sustained attention during joint attention episodes that directly predicts infants' vocabulary at 12 and 15 months (Yu, Suanda, & Smith, 2018).

In summary, taken together, the research findings underscore the importance of caregivers' attention directing their infants' attention during early social interactions. During parent-infant interaction, parents' direction of attention which includes their looks to an object of interest, object manipulation, and naming the object of interest serve two critical joint

attention goals – (a) to elicit infants' attention to the object by getting them to switch their gaze from their mother to the object, and (b) to get infants to attend to the object for a prolonged period of time once it is captured.

Child-Directed Joint Attention and Word Learning

Child-directed joint attention, where the infant or child initiates or directs the shared attention with their caregiver during everyday interaction, is considered to be a contingent form of social coordination. Furthermore, some researchers consider child-directed joint attention to be a more sensitive form of joint engagement in social contexts relative to parent-directed joint engagement, discussed in the prior sections (e.g., Akhtar, Dunham, & Dunham, 1991; Mason, Kirkpatrick, Schwade, & Goldstein, 2019). Child-directed joint attention between 5-month-old infants and their caregivers has been found to contribute to increased infant looking preferences to novel objects and positive reactivity to caregivers' social cues (Mason, et al., 2019).

Child-directed joint attention has also been directly linked to vocabulary development. Some proponents of joint attention's influence on early vocabulary development have suggested that if caregivers name objects when their toddlers first attend to the objects of interest (i.e., when the joint attention episode is initiated by the infant) and recruit their caregivers' attention to that object, then the toddlers learn the object's name better than when caregivers direct their toddlers' attention to an object and subsequently name the object (Akhtar et al. 1991). Scott, Sakkalou, Ellis-Davies, Hilbrink, Hahn, and Gattis (2013) directly compared the contribution of infant-initiated joint attention with mother-initiated joint attention to British infants' expressive vocabulary during naturalistic play episodes. Play episodes were recorded from thirty-six mother-infant pairs when the infants were 14, 15, 16, 17, and 18 months of age. Both types of joint attention were positively correlated with infants' vocabulary which steadily increased with age. That is, infants who showed higher levels of infant-initiated joint attention as well as infants whose mothers showed higher levels of mother-initiated joint attention during the play episodes showed significantly greater number of words in their vocabulary than the infants who showed lower levels of infant-initiated joint attention as well as infants whose mothers showed lower levels of mother-initiated joint attention during the play episodes. Overall, however, they found that infant-initiated joint attention was a far better predictor of expressive vocabulary development than mother-initiated joint attention.

One possible reason for infants' greater vocabulary when they engage more frequently in infant-initiated joint attention in the second year is that, in play interactions with their caregivers even as early as during their first year (from 4- to 9 months), infants' greater looks towards an object of interest elicit more frequent and contingent maternal naming of that object, providing increased opportunities for infants to learn the names for the object of interest (Chang, de Barbaro, & Deák, 2016). Similarly, Carpenter, Nagell, and Tomasello (1998) found that two factors during mother-infant interaction, the length of time infants engaged in joint attention with their mothers, and the extent to which mothers vocalized after their infant attended to an object of interest, predicted infants' gestural and linguistic communication from 9- to 15 months, These findings suggest, once again, that infants' looks to an object of interest elicits maternal naming during joint attention episodes.

By the end of their first year, some predominant strategies that infants use to direct their caregivers' attention to an object of interest are gestures towards the object and declarative pointing to it. For example, Boundy, Cameron-Faulkner, and Theakston (2019) found that when 10-month-olds performed a hold-out gesture, extending an object of interest to an adult, if the adult engaged in joint attention with the infant and the object, rather than to either the object or the infant alone or to neither, the infants showed a more positive attitude and little message correction behaviors. As another example, Liszkowski, Carpenter, and Tomasello (2007) found that during an experiment, when an adult attended to the correct object that one-year-old infants pointed towards, then the infants pointed to the object more often and showed a more positive attitude (versus frustration) and no message repair (did not repeat the point). In contrast, when the adult did not attend to the correct object that the one-year-olds intended to engage the adult in, the infants engaged in message repair (immediately repeated the point to the correct object) and showed frustration, but overall displayed less pointing during the experiment. These findings establish that one-year-olds use hold-out and pointing to engage adults in infant-directed joint engagement.

In summary, taken together, the research findings underscore that infants, not merely caregivers, initiate and direct others' attention to objects resulting in joint attention episodes. This includes infants' looks to an object of interest, their object manipulation, as well as holding-out an object of interest, and pointing to it, to elicit and actively engage caregivers' attention.

Cultural Variations in Joint Attention

Thus far, in this chapter, I have highlighted the highly interactive process of word learning mediated by both caregiver- and child-directed joint attention. An aspect of joint attention that deserves consideration, given the well-documented variations in mother-infant interaction involving objects, is that joint attention varies in parent-infant interactions across cultures around the world. For example, one study showed that caregivers from the United States use visual cues such as eye-gaze or pointing more often during play interaction with their 29-month-olds while exploring a novel object when compared with Ni-Van caregivers from a non-Western indigenous culture from Vanuatu, who use tactile cues more often during caregiver-child interactions while exploring the same object (Little, Carver, Legare, 2016). The authors concluded from these cross-cultural findings that the western model of early social learning differs from that of other cultures.

In spite of the lower frequency of joint attention episodes or its entire absence in some cultures, young children around the world typically learn new words and develop a sizable vocabulary by three years of age. Hence, although joint attention facilitates infants' word learning in some cultures, it is unlikely to be a necessary prerequisite for word learning in all cultures (Akhtar, 2005). Supporting the view that joint attention is not a necessary prerequisite for word learning, Akhtar and colleagues illustrated that infants of 18 months or older even from Western cultures, where joint attention episodes are frequent during interaction, are quite capable of learning new object labels by overhearing conversations between third parties (e.g., a parent and another adult or an older sibling), in the absence of adult-directed or child-directed joint attention (Akhtar, Jipson, & Callanan, 2001; Floor & Akhtar, 2007). Young children of 2.5 years are able to learn action labels similarly, by overhearing conversations between third parties (Akhtar et al., 2001).

Conclusions and Clinical Applications

At least in Western cultures, the ability to engage in shared attention develops over time with the earliest evidence found at 2 months, and stabilizes between 6 and 8 months of age (e.g., Gredebäck et al., 2010). Joint attention progresses from infants initially following their caregiver directed attention to later directing caregivers' attention during everyday social interactions (Carpenter et al., 1998). Furthermore, the evidence suggests that shared attention episodes between caregivers and their infants in the

first year contribute to the development of infants' sustained attention to objects that the caregiver potentially names (Mason et al., 2019). Reciprocally, infants' sustained attention contributes to joint attention episodes between infants, in the second year, and their caregivers. Attention to naming contexts develops over time (Gogate, & Maganti, 2016). Similarly, sustained attention to objects increases over time during the first year (Wiener, Thurman, & Corbetta, 2018).

Both caregiver-directed and infant- or child-directed joint attention play an important role in word learning. Thus, during caregiver-directed joint attention episodes, caregivers' manual actions upon objects and looks in the direction of objects of interest elicit infants' gaze switching or their following the gaze of their caregiver to the objects. In addition, during infant-directed joint attention episodes, infants' looks to an object, or their hold-out gestures and pointing serve to direct caregivers' interest to objects originally of interest to the infants.

Finally, notwithstanding the main thesis of the present chapter, that joint attention influences word learning, two important caveats deserve consideration. First, rather than assume that the relation between joint attention and word learning is unidirectional (i.e., that joint attention development leads to word learning) it must be emphasized here that the relation between joint attention and word learning is bidirectional (Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002), with each ability enhancing the other during early development. Second, although joint attention is predominant in parent-child interactions with objects and actions in western cultures, not all cultures use joint attention as frequently in interaction prior to learning words. Children in those non-western cultures still learn words using other means (Akhtar, 2005; Little et al., 2016). The cultural variations in the use of joint attention have important implications in the clinical evaluation of children from non-western cultures who do not initiate joint attention episodes with their parents and exhibit vocabulary delays. In these cases, diagnosing the lack of joint attention as a red flag for language development would be culturally insensitive. In other words, in cultures where joint engagement during interaction is not the norm, its absence cannot be a red flag for delayed vocabulary. One must look for and utilize alternative "culturally relevant" strategies during these parent-child interactions that facilitate word learning.

CHAPTER SEVEN

WORD LEARNING BY BILINGUALS AND MONOLINGUALS: SIMILARITIES AND DIFFERENCES IN THE EARLY YEARS

There is a consensus among scholars that the basic mechanisms for word learning are the same for bilingual and monolingual infants and children (Butler, 2019; De Houwer, 2009; although early bilingualism changes the brain mechanisms or regions for selective attention to continuous speech in adults, Olguin, Cekic, Bekinschtein, Katsos, & Bozik, 2019). Recent empirical research suggests, however, that there are important variations in the developmental timing of specific language milestones in bilingual versus monolingual language learners, based on the quantity, quality and the age of acquisition of the second language (L2).

Sequential bilinguals, who learn a second language after they have learned their first language, exhibit developmental differences in their receptive and productive vocabulary relative to monolingual toddlers and children. The extent of L2 vocabulary learned depends largely on the age of acquisition of the L2 (Bylund, Abrahamsson, Hyltenstam, & Norrman, 2019). Byers-Heinlein and Lew-Williams (2013) suggest as well that for children to become truly bilingual, they need to be introduced to the L2 as early as possible. A number of other factors such as relative extent of exposure to the language, and socio-economic status are also known to contribute to L2 vocabulary learning (Hoff, 2013).

In simultaneous bilinguals, who are exposed to more than one language at birth, developmental differences are observed in the overall length of time that they perceive the sounds that make up words in their bilingual environment relative to monolingual infants and toddlers. Owing to exposure to two languages starting in the womb, bilingual infants' perception of certain properties of language, not present in their dominant languages, remains pliable for a longer period of time relative to the perception of monolingual infants. The earliest evidence for this pliable

perception as a result of environmental experience to an additional language is observed in bilingual newborns. They perceive sounds that occur in their native languages and sounds in non-native languages (that they might not have heard in the womb). In comparison, monolingual newborns only perceive the sounds that belong to their native-language environment and tune out the sounds that do not occur in the native-language environment (Byers-Heinlein, Burns, & Werker, 2010).

The narrower perception has cascading effects on monolingual infants' word learning, as their perception and learning narrow further with time, and they only attend to languages of the same family as their native-language. For example, Perszyk and Waxman (2019) have shown that young monolingual infants of 3- to 4 months, from English speaking backgrounds, successfully pair German vocalizations (whose prosody is similar to that of English) with objects, but not Cantonese vocalizations (whose prosody differs markedly from that of English) with the same objects. Their perception and learning narrows even further with time, and they attend to the specific accent/dialect of their native language environment. Thus, monolingual toddlers have difficulty learning words from adults with a different accent when there is a potential confusion between vowels (Newman, Morini, Kozlovsky, & Panza, 2019). At 17 months, monolingual English learning toddlers learn words with minimal differences (i.e., /kɛm/ – /gɛm/) best from a monolingual speaker resembling their home language environment, whereas bilingual (French and English learning) toddlers learn the same words best from a bilingual speaker who resembles their home language(s) environment (Fennell & Byers-Heinlein, 2014). Monolingual toddlers' difficulty when learning from adults with different accents/dialects could also depend on which foreign language accent speaker of English the toddler encounters on a daily basis, and the age of the toddlers.

If such remarkable differences in perception of the basic building blocks of language(s) are evident even at birth and persist during the early years due to exposure versus the lack of it to an additional language (starting in the womb), how else might bilingual and monolingual infants differ in their language learning due to exposure to two versus one language? In the present chapter, I highlight some of the differences as well as similarities between bilingual and monolingual learners in their receptive and expressive vocabulary development in the early years. The implications of these differences for language education, in particular preschool language readiness, are also discussed, given that age-appropriate vocabulary development is fundamental to children's grammatical development as well as later developing literacy skills.

Preverbal Infants' Attention to the Native-Language: Monolinguals and Bilinguals

Long prior to being able to put words and objects or actions together, infants are adept at tuning into and attending to specific properties of their language environment, and show a preference for their native (familiar) language relative to an unfamiliar language. Exposure to an additional language allows infants to better perceive and detect similarities between neighboring languages (e.g., Catalan and Spanish). For example, as early as 4 months of age, bilingual infants make fine-grained distinctions between languages that are dissimilar. They look longer to the mouths of speakers of the related languages (e.g., Catalan or Spanish) relative to the speakers of an unrelated language (e.g., French). In comparison, monolinguals (e.g., Spanish learning infants) who have already tuned out the non-native language(s) do not show a preference for the related language (e.g., Catalan). These infants rely on their ability to perceive the prosodic (e.g., pitch, rhythm, stress pattern) differences between the dissimilar languages to distinguish between them (Bosch & Sebastian Galles, 1998). Around 11 months, not only do bilingual infants orient longer towards the native-language speaker, but they also imitate the facial expressions, such as mouth opening and eyebrow raising of the native-language speaker more frequently than they do the expressions of a foreign-language speaker (De Klerk, Bulgarelli, Hamilton, & Southgate, 2019). These findings, taken together, suggest that infants attend to and become highly familiar with the facial movements and voice of the native-language speaker prior to being able to talk.

When attending to speakers, both monolingual and bilingual (hearing English 48% of the time) infants, between 4 and 8 months, switch attention increasingly to their mouth when they encounter audio-visual speech (Mercure, Kushnerenko, Goldberg, Bowden-Howl, Coulson, Johnson, & MacSweeney, 2019) regardless of the language they hear (Lewkowicz & Hansen-Tift, 2012). Selective attention to the mouth is also associated with expressive language skills in monolingual and bilingual infants around 11 months of age. However, around 12 months, infants shift their attention back to the speaker's eyes as long as they hear their native language, but continue to attend to the speaker's mouth if they hear a non-native language (Lewkowicz & Hansen-Tift, 2012). These findings taken together suggest that although attention to the mouth is one means by which infants develop a vocabulary regardless of language background (Tsang, Atagi, & Johnson, 2018), there is an interaction between attention to the mouth versus eyes and monolingual versus bilingual status. In a recent study of monolingual

(English or French) and bilingual (English and French) children from 5 months to 5 years and adults, Morin-Lessard, Poulin-Dubois, Segalowitz, and Byers-Heinlein (2019) found that, unlike adults, children up to 5 years looked more to the mouth than the eyes of a talking face. There was little evidence for different patterns of attention to eyes versus mouth in monolinguals versus bilinguals, or to a native versus a non-native speaker. However, monolinguals who spoke more words looked more at the mouth, whereas bilinguals who understood more words looked marginally less at the mouth. Notwithstanding these differences, in general, the findings, taken together, suggest that for bilingual children, similar to their monolingual counterparts, attending to the speaker's mouth is a prerequisite for speech and language development. For monolingual and bilingual children, paying close attention to the speaker's mouth serves as an important means by which aspects of language can be learned starting about 4 months and continues to remain so until about 5 years of age (cf., Lewkowicz & Hansen-Tift, 2012).

Word Mapping: Bilinguals versus Monolingual Infants

Infants start to map words onto objects (i.e., put words and objects together) by about 6- to 8 months of age (Friedrich & Friederici, 2017, report word-object mapping as early as 3 months). Although this milestone is well established for monolingual infants, bilingual infants arrive at these milestones using a somewhat different route, because their language environment differs from that of monolingual infants (DeAnda, Poulin-Dubois, Zesiger, & Friend, 2016). Some studies that have examined word-object mapping in the second half of the first year have noted that, during their first year, bilingual infants do not differ in their word-object mapping relative to monolingual infants of the same age at least initially (e.g., Gogate et al., 2006; Matatyaho et al., 2014). Until about 14 months as well, bilingual infants appear not to differ from monolingual infants in their ability to map words onto objects. Byers-Heinlein, Fennell, and Werker (2013) exposed 12- and 14-month-old monolingual infants from English speaking homes as well as bilingual infants to video segments of two distinct words, such as neem and lif, each paired with a novel object. The language environment of the bilingual infants consisted of English and another language such as Cantonese, Japanese, Punjabi, Farsi, French, Italian, Spanish, Dutch, German, Russian, Arabic, Catalan, Czech, Danish, Hebrew, Portuguese, Romanian, Tagalog, Tigrigna, or Yoruba. Following exposure to the two word-object pairings, the infants were given a test in which the word-object pairings were interchanged. Surprisingly, at 12 months, both monolingual

and bilingual groups showed no learning of the pairings, which contradicts what is known about infants' ability to successfully put words and objects together much earlier (e.g., Gogate et al., 2006). At 14 months, however, both the bilingual and monolingual infants successfully learned the pairings, once again, with no significant differences between the two infant groups.

At slightly older ages, however, differences are observed in word-mapping success between monolinguals and bilinguals under specific conditions. Mattock, Polka, Rvachew, and Krehm (2010) exposed bilingual (English and French) and monolingual (English or French) infants of 17 months to words such as *bowce* and *gowce*, spoken by an adult bilingual with English and French accents. Each word was paired with a novel object during initial exposure. Next, infants were tested with the same words and objects in a novel pairing (switch) versus the same word-object pairings. On the test, whereas the bilingual infants looked longer to the switched relative to the same pairings, illustrating learning of the word-object pairings, the monolingual infants failed to look longer to the switched pairings, illustrating no learning. The monolinguals only learned the pairings when the words were presented in their native language accents, suggesting that by 17 months, these infants have tuned out non-native accents. This is because, as discussed earlier, monolinguals tune out the sounds of non-native languages sooner than bilinguals. For bilinguals, the phonological (sound perception) system narrows more slowly, allowing the perceptual window to remain open for a longer time-period. This open window, in turn, results in more flexibility during word learning compared to monolingual infants. For example, when the native language does not use pitch contrasts to differentiate between names for objects, monolingual toddlers tune out these contrasts between 17 and 19 months (Hay, Graf Estes, Wang, & Saffran, 2015), whereas bilingual toddlers continue to perceive the contrast much longer until 22 months (Graf Estes, & Hay, 2015). Similarly, when the names for objects differ in their vowel sounds (e.g., /min/ and /mun/) bilingual (Mandarin and English learning) 18-month-old infants pair each of the words with an object, but not monolingual infants of the same age (Singh, Fu, Tay, & Golinkoff, 2017).

Monolingual infants' word learning reflects differences in the overall priority given to nouns versus verbs in the language(s) they are learning based on their language environment. Languages differ in whether they are noun or verb friendly (heavy). For example, the English language tends to be more noun-friendly. Caregivers in English speaking environments use nouns more frequently and use a greater variety of nouns relative to verbs when they interact with infants. Therefore, English learning infants tend to learn nouns before they learn verbs (Nelson, Hampson, & Shaw, 1993), and

learn more nouns overall relative to verbs (Kim, McGregor, & Thompson, 2000). In comparison, languages such as Chinese and Korean tend to be verb-friendly. Thus, caregivers in Mandarin speaking environments tend to use verbs more frequently and use a greater variety of verbs. Reciprocally, infants in these environments learn more verbs than infants from English speaking environments (Choi, 1998). Thus, when infants' overall production of the first 10 words (starting around 11 months) is compared across infants learning English versus Mandarin Chinese or Cantonese, the English learning infants produce far more common nouns (*Mean* - $M = 19.4$, *standard deviation* - $SD = 26.2$) than the Mandarin ($M = 5.7$, $SD = 13.2$) and Cantonese ($M = 3.2$, $SD = 10.1$) learning infants, commonly known as a noun bias. In contrast, the Mandarin ($M = 4.8$, $SD = 12.7$) and Cantonese ($M = 7.0$, SD = 4.6) learning infants produce far more verbs than the English learning infants ($M = .7$, $SD = 4.3$; Tardif, Fletcher, Liang, Zhang, Kaciroti, & Marchman, 2008).

These language environment differences, specifically, the differences in the overall priority given to nouns versus verbs also influences the time-period when monolingual versus bilingual infants learn to map novel words onto actions, a prerequisite for verb comprehension. For example, monolingual infants who are learning English, a noun-friendly language, map two distinct spoken words such as *wem* and *baf* onto two different actions using an object, looming and shaking, at 8- to 9 months (Gogate & Maganti, 2017). Following initial exposure to the two video segments of an actor performing the two actions, each paired with one of the words, the infants looked longer on test trials where the word-action pairings were interchanged compared to trials where the word-action pairs remained the same as during initial exposure. By 10.5 months, however, monolingual infants fail to learn the same word-action relations suggesting that their perceptual system is temporarily tuning into nouns in their noun-friendly language at the expense of verbs (a noun bias). In comparison, bilingual infants of 10.5 months, who are learning two noun-friendly languages (e.g., English and Spanish) retain their ability to put these words and actions together (Gogate & Maganti, 2020). Thus, by 10.5 months, although both bilingual and monolingual infants alike are tuning into the relatively greater frequency of nouns versus verbs in their native language(s), this tuning develops later in the bilingual infants relative to the monolingual infants of the same age likely because, once again, their perceptual window remains open for a longer period of time to accommodate languages that are noun and verb-friendly compared to that of monolingual infants at 10.5 months. However, although this perceptual tuning into nouns occurs later for bilinguals learning two noun-friendly languages, once the infants start to

produce nouns (and verbs, as indicated on maternal responses to a standardized vocabulary checklist, the MCDI), their noun bias accelerates. Thus, by 12.5 months, bilingual infants who are learning English and another noun-friendly language performed far worse, showing attenuation on the word-action mapping task relative to monolingual infants (Gogate & Maganti, 2020). In comparison, the word-action mapping attenuation was more pronounced later, around 14 months, in monolingual English learning infants (Gogate & Maganti, 2017). By 18 to 20 months, infants appear to map both nouns and verbs readily (English, de Carvalho, Lidz, He, Christophe, 2019; He & Lidz, 2017; English, French, and Japanese, Katerelos, Poulin-Dubois, & Oshima-Takane, 2011). However, the noun-bias once again weighs heavily a bit later on, and results in even 2-year-old monolinguals learning English to prefer to map a word to an object over an action (Kersten & Smith, 2002).

In summary, the findings on word-object mapping suggest clearly that beyond 17 months, bilinguals differ from monolinguals in their ability to map nouns onto objects. In addition, the findings on word-action mapping suggest that the time period when infants begin to map verbs onto actions differs for infants learning two noun-friendly languages (e.g., English and Spanish) versus one, evident at 10.5 months. To date, we know little about how this time period for learning might differ in the case of bilingual infants learning a verb-friendly (Chinese) and a noun-friendly language (English) or two verb-friendly languages (e.g., Chinese and Korean; cf., Katerelos et al., 2011). Such knowledge could inform best practices for early education of bilingual populations around the world. In particular, such knowledge could inform the education of bilingual children from immigrant families (e.g., in the United States or United Kingdom) who are exposed to a verb-friendly home language and learn noun-friendly English in a daycare or preschool.

Word Comprehension: Bilinguals versus Monolinguals

As discussed in the prior subsections, in their second year, bilingual infants maintain an open perceptual window for a longer period of time than their monolingual counterparts. This open window allows them to learn words in two languages relative to monolingual infants. However, there appear to be some constraints on the optimal time to learn a second language. A recent study examined preschoolers' learning of English as a second language (L2) from linguistically stable societies, such as in Malta, where English is learned in school after learning Maltese, their first language. The study showed a difference

between 3- and 4-year-olds' acquisition of English, with the older, 4-year-old children learning English vocabulary at a slower pace than the 3-year-olds (Gatt & Dodd, 2020). This finding suggests an optimal period for catching up with English as a second language around 3 years of age. It implies that if children are exposed to the second language after their 3rd year, their pace of learning that second language slows relative to those who are exposed to the second language prior to the third year (see next subsection for evidence of slower expressive vocabulary learning, and slower word processing in bilinguals in each language after 22 months).

Research shows that fast-mapping or the ability to learn the meaning of a word after encountering it only once or a few times in context is typical of monolingual children (Samuelson & McMurray, 2016). Sequential L2 learners, however, are slow to learn these meanings and often learn the meanings only partially. For example, English-learning German children ages 3-6 years show difficulty remembering the exact objects that were labeled in the L2, although they remembered the broad semantic field from which the objects were chosen (Rohde & Tiefenthal, 2000).

Expressive Vocabulary Learning: Bilinguals versus Monolinguals

In spite of the clear differences between bilingual and monolingual infants in the time period for word mapping reported in the earlier subsections, studies have shown that the onset of first word production in bilinguals and monolinguals does not differ (Genesee, 2003). One possible explanation for the insignificant group differences in first word production might stem from the greater degree of individual variation of overall words produced by monolingual and bilingual infants and toddlers in the first two years, the earliest period of word production (Fenson et al., 1994). This variation in production stems largely from the variation in parental communicative input in one or both languages (Song, Wu, & Yoshikawa, 2012). Between 17 and 22 months as well, after assessing vocabulary using standardized tests, a longitudinal study of English and French learning monolingual versus bilingual toddlers reported no significant differences in expressive (and receptive) vocabulary (Legacy, Zesiger, Friend, & Poulin-Dubois, 2018).

Soon after, from 22-30 months, given that bilingual infants and toddlers learn words in two languages whereas monolinguals learn words in one, the rate of word learning in each language is slower for the bilingual

toddlers. However, their overall vocabulary across the two languages is comparable to that of the monolingual infants' vocabulary in a single language (Core, Hoff, Rumiche, & Señor, 2013). This slower rate of vocabulary development in each language is also reflected in bilingual children's slower processing of words within each language being learned at 2.5 years (22-30 months). For example, Marchman, Fernald, and Hurtado (2010) found positive within-language correlations between the Spanish and English learning children's reaction times during familiar word recognition and their vocabulary size but did not find cross-language correlations. In other words, if the children reacted quickly during the familiar word recognition task in English, their vocabulary was greater in that same language (English) but not in Spanish. Yan and Nicoladis (2009) have reported a moderate disadvantage for expressive language, with bilinguals lagging further behind monolinguals on expressive vocabulary tests and showing more difficulty in word access than monolinguals on naming tasks. This group difference in word production was observed in spite of the great deal of individual variation reported in bilingual infants' vocabulary development in the first two years of life (Song et al., 2012). As discussed earlier, bilinguals might on the other hand have an advantage in learning words from bilingual speakers (Fennell & Byers-Heinlein, 2014) with different accents. Monolingual toddlers experience difficulty learning words from adults who speak different accents especially when there is potential confusion between vowels (Newman et al., 2019).

Summary, Conclusions, and Implications for Early Bilingual Education

In summary, although the basic mechanisms for word learning are likely the same, bilingual and monolingual infants and toddlers clearly differ in many aspects of their word learning, in particular, in the developmental timing of their word learning. The timing distinctions manifest in a relatively open perceptual window in bilingual learners that allows learning of words with sounds from more than one language right from birth (Byers-Heinlein et al., 2010). They also manifest as distinct word-object mapping patterns observed in toddlers around 17 months (e.g., Singh et al., 2017), and word-action mapping patterns observed in bilinguals as early as 10-12 months (Gogate & Maganti, 2020), once again suggesting an open and pliable window in a system that accommodates more than one language. In addition, it is well established that distinct receptive and expressive vocabulary patterns manifest as slower rates of word learning by bilingual children during learning of each of their two languages. In the case

of sequential bilinguals this slower rate of word learning correlates with slower processing of words in the second language (Marchman et al., 2010), slower rates of fast-mapping in the second language (Rohde & Tiefenthal, 2000), and a slight delay in overall expressive vocabulary at 4 years relative to 3 years (Gatt & Dodd, 2020; Yan & Nicoladis, 2009). These delays place bilingual children at a disadvantage relative to their monolingual counterparts when learning words in a second language when the second language also happens to be the medium of instruction within the educational system. At the same time, a specific disadvantage observed in monolingual children is the relative difficulty in learning words from speakers with foreign accents when there is confusion in the vowel sounds (Newman et al., 2019). In comparison, owing to a diverse language environment, bilingual toddlers learn words from bilingual speakers relatively easily (e.g., Fennell & Byers-Heinlein, 2014).

Given these manifold differences, the primary challenge for parents and educators of bilingual children then is to enhance second language vocabulary starting around the second half of the first year with the aim to get it to a level comparable to that of the monolingual children of the same age. If, as per the consensus among scholars, the basic mechanisms for word learning are similar for bilingual and monolingual infants and toddlers, all of the strategies proposed in earlier chapters for enhancing word learning in monolingual infants, toddlers and young children (e.g., Dickinson et al. 2019; Toub et al., 2018) should also enhance word learning in their bilingual counterparts.

One strategy that clearly enhances children's vocabulary in the second language, as is the case with first language learning (Hart & Risley, 1995; 2003), is to increase the quantity and quality of exposure to the L2 on a daily basis. Due to increased exposure to the L2 right from birth, simultaneous bilinguals have a clear advantage over sequential bilinguals for becoming proficient in the L2. In the case of sequential bilinguals, who become exposed to the L2 after first being exposed to the first language, it is recommended that earlier exposure is far better than later exposure with a minimum threshold of 25% of total daily L2 exposure to become proficient in the L2 (see review by Byers-Heinlein & Lew-Williams, 2013). Greater exposure to the L2 (Spanish) at 30 months is directly related to greater vocabulary in the L2 six months later (Hurtado, Gruter, Marchman, & Fernald, 2014). Furthermore, it is recommended that exposure to the L2 occur during playful interactions given that children learn best during such interactions as opposed to formal classroom interactions (Byers-Heinlein & Lew-Williams, 2013).

Another strategy that has been shown to enhance vocabulary in bilingual preschoolers learning English (L2) is the use of non-verbal multimodal aids such as pictures and gestures accompanying the novel words during teaching (Rowe, Silverman, & Mullan, 2013). As discussed in Chapter 3, Toumpaniari and colleagues (2015) taught 4-year-old Greek children novel foreign language English words for animals (e.g., dog) over a 4-week teaching period. They used one of three different instructional methods - words accompanying physical enactment (e.g., moving like a dog on all fours) and gestures (e.g., pant like a dog), words accompanying gestures (e.g., say the word and pant like a dog), or words with neither gestures nor physical enactment of the words (e.g., repeat the word after the teacher). Children were asked to provide the meaning of the words during subsequent one hour per week teaching sessions, using the same method in which they had been instructed earlier. At the end of the 4-week period, the children were tested for their word learning. The children who were taught the words along with the physical enactment and gesture learned the words far better than the children who were taught the words using neither of the two instructional methods. These findings, similar to that of Rowe et al. (2013), illustrate that relevant activities accompanying novel word teaching promote word learning. To complement these findings on children's learning (discussed earlier in Chapter 3), research assessing more than 9000 words in the English language has shown that words that are associated with and require the interaction of body parts are "more concrete, more graspable, and more strongly associated with sensory, haptic, and visual experience" than words that do not involve an interaction with specific body parts (Pexman et al., 2019). When teaching a second language, therefore, infants and children need to be introduced to the former word types prior to the latter word types to make it easier for them to learn the second language.

Yet another documented strategy for enhancing vocabulary in preschool children is story book reading at home and at preschool in both L1 and L2. For example, Roberts (2008) showed that L2 (English) vocabulary was enhanced in preschool-aged children who were learning either Hmong or Spanish (L1) in the United States with home-based story book reading in L1 and L2. Furthermore, reading the same story in the children's first language at home and in English at preschool over a 6-week period enhanced English vocabulary in these children far more than when the story was read in English alone at home and at school. These findings suggest that home-based reading in the L1 helps to reinforce concepts in preschool-aged children far better than reading in the L2 alone. Contrary to the scientific evidence presented here, popular preschool curricula to the

present day recommend and engage in immersion L2 learning programs that exclude the L1 at the expense of L2 in daily activities.

In conclusion, when the L2 happens to be the dominant language used in the community, it is quintessential to facilitate "catch-up" in bilingual L2 learners so that they can gain proficiency in the second language to perform optimally in school, be mainstreamed and become functional in the dominant-language speaking community. It is equally important in increasingly multicultural societies to expose monolingual infants, toddlers, and children to adults with different dominant language accents (e.g., New York and Midwestern English accents in the US). In increasingly mobile and multicultural communities, such as the urban United States, such exposure to different accents is necessary to alleviate monolingual dominant language learning toddlers' difficulty when learning from secondary caregivers, teachers, and other professionals with different accents than the one they are used to hearing at home. These measures must be taken prior to preschool entry so as to ensure that the cascading effects of children's perceptual and language delays do not spill over into other domains of their elementary and higher educational milestones.

CHAPTER EIGHT

CONCLUSIONS, QUESTIONS, AND FUTURE DIRECTIONS

It is incontrovertible that primary caregivers educate or highlight their infants' attention to naming contexts while engaging with objects or activities with the objects. Thus, live interactions with primary caregivers, not video interactions, enable infants of 5-6 months onwards to separate words from a stream of speech and learn the word-object relations (Hakuno, Omori, Yamamoto, & Minagawa, 2017). Chapters One through Six of this volume established that primary caregivers direct their infants' attention to word learning contexts using a wide array of strategies that contribute to infants' word learning. In these chapters, the research showed that mothers use strategies such as variations in prosody (e.g., higher pitch at the end of short sentences while placing the novel name at the end of the sentence), timing overlap between novel spoken words and object motion, specialized gestures such as showing an object or action during naming, or pointing to an object during naming, and space manipulations such as naming an object consistently in the same location for infants in their first year.

For infants in their second year as well, caregivers use a wide array of strategies during naming that are associated with early word learning. For example, Wei, Ronfard, Leyva, and Rowe (2019) have identified that parents of 20-month-olds use one of two distinct and broad strategies while engaging with their infants in word teaching contexts. Parents can be broadly categorized as "scaffolders" versus "labelers". The scaffolders elaborate on novel objects and ask questions about the objects, whereas the labelers simply label the objects, or use novel words without providing supporting information so the children can understand their meanings. Both word learning and later vocabulary growth are greater when the parents are scaffolders than when they are labelers, with positive long-term benefits for their infants. Furthermore, for successful word learning to take place, the conversations between caregivers and their toddlers of 24 months must be uninterrupted. For example, Reed, Hirsh-Pasek, and Golinkoff (2017) reported that if maternal teaching of two novel verbs was interrupted by a

30-second phone call to the mother, the toddlers failed to learn the two novel verb-action relations. Word learning was interrupted even though some of the toddlers waited during their mother's phone conversation, whereas other toddlers simply moved on to other sources of distraction during their mother's phone conversation. In stark contrast, the toddlers who received uninterrupted teaching of the same verbs successfully learned the relations between the verbs and the actions, suggesting that the quality of the mother-toddler interaction matters.

It is also incontrovertible that infants contribute to their own word learning. They actively perceive and act upon the word learning contexts presented to them by their caregivers, or initiate opportunities for word learning in multiple adaptive ways. For example, as was discussed in the previous chapter, as early as 2 months, infants start to shift their own gaze in the direction of caregivers' object manipulation. Infants between the ages of 2 and 8 months also begin to gradually attend significantly longer to dynamic speaking faces than they do other auditory-visual events (e.g., audio-visual objects; Bahrick, Todd, Castellanos, & Sorondo, 2016), and look away less often to the speaking faces compared to the other auditory-visual events during the same time period. At about 6 months they begin to shift their gaze when mothers name and manipulate an object. By 9 months, they attend for long periods of time to the objects that their caregivers move and name, which reliably predicts the number of words in infants' repertoire at 12 and at 15 months (Yu, et al., 2018). In addition, infants begin to direct their caregivers' attention to objects of interest by looking at, pointing to, or manipulating an object, which leads to shared attention between infants and caregivers.

A major take away message to parents and professionals, from such research findings on the behavior of caregivers and infants, is that everyday social interaction dynamics between infants and their caregivers ensure ample opportunities for word learning. These dynamic and reciprocal social interactions are mutually adaptive in nature. As a case in point, parental gestures and infants' word learning adapt to one another. Thus, mothers use looming and shaking actions simultaneous with object names to highlight label-object relations for 6- to 8-month-olds (Matatyaho & Gogate, 2008). Reciprocally, infants of 8 months of age learn the label-object relations best from an adult when, in experiments, novel objects are held and moved, one at a time, using looming or shaking actions (Matatyaho-Bullaro et al., 2014). We see further evidence for a mutually adaptive relation between infants' and parents' actions. For example, infants' increased actions during a nesting cup activity with the parent makes the parent adapt their actions accordingly during the interaction (Fukuyama et al., 2014). These infant and

maternal strategies could be adopted in the design and implementation of developmentally appropriate interactive interventions for infants at risk for language delay after their success is scientifically documented in randomized-controlled intervention research (see Footnote 1).

Having emphasized the quintessentially interactive nature of word learning, it is also worth noting that not all strategies discussed in the prior chapters are guaranteed to work with all infants at all times due to individual variations in vocabulary development (Fenson et al., 1994). Additionally, the types of interaction between caregivers and children across cultures vary widely, resulting in varied language learning environments that children encounter around the world (Gogate, Maganti, & Bahrick, 2015; Scheiffelin, 1979; Watson-Gegeo, & Watson, 1986; Reddy et al., 2013). Furthermore, not all strategies work with toddlers experiencing vocabulary delays, because strategies for teaching words to the atypically developing child may also vary depending on the type of delay. For example, typically, 2-year-olds use the speaker's direction of gaze towards a novel object when the speaker names it to learn the novel name for that object. However, children with autism fail to use the very same strategy to learn the correct word-object mappings (Baron-Cohen, Baldwin, & Crowson, 1997). In direct contrast to the strategies employed with typically developing children, taking away the face while naming and teaching words to children within the Autism Spectrum, or providing simplified fuzzy robotic toys rather than complex humans helps these children to learn the names for objects (e.g., Patten et al., 2017; Prince & Gogate, 2007).

Some Further Questions: Unresolved Issues

Several areas within the broad domain of word learning deserve consideration and future research investigations. Some of these areas are enumerated below in detail.

Hierarchy of strategies for learning words

The specific strategies infants use most at any given time to learn words change throughout the course of their development. In other words, during the course of infants' development, their ability to attend to (and use) some strategies take on increasing salience while others become less salient. These changes are contingent upon multiple factors. Their interactions lead to several predictions about infants' use of strategies during word learning. Three of these predictions are elucidated here.

First, it can be predicted that infants might learn word-object relations without the aid of spatial co-location earlier (6 months) than without the aid of temporal synchrony. This prediction is based on the evidence that, when shown everyday auditory-visual events such as a bouncing ball impacting a surface, even newborn infants detect the common location from which the sight and sound emanate (spatial co-location; Morongiello, et al., 1998). In contrast, when the sound and sight of these events are made to artificially emanate from two different locations rather than from a single location, as they naturally occur in the environment, the newborns consider them to be a violation of their expectation by looking longer to these artificially created events. However, it is not until about 4 weeks later that infants detect the coincidence in timing between the sight and sound of the bouncing ball (synchrony; Bahrick, 2001). Extrapolating from this hierarchy in the perception of spatial co-location versus synchrony in auditory-visual events, we can predict that, later in the first year, infants will likely perceive and learn word-object relations, another auditory-visual event, in the absence of spatial co-location (6 months) earlier than in the absence of synchrony (10 months; also see evidence for such a hierarchy, Lewkowicz, 2002; Sullivan & Horowitz, 1983).

Second, it can be predicted that infants will likely learn and recognize familiar words in sentences earlier and better when voice and face are presented simultaneously than when only the voice is presented. Given the inherently multisensory nature of word learning, recognizing newly learned and now familiar words in one sensory modality (auditory) alone is far more difficult than learning and then recognizing the words across two sensory modalities. Infants recognize words as early as 5 months after exposure to passages in which the words occur repeatedly in sentences, if the words (and sentences) are presented in synchrony with the face of a person reciting the passages, but not if the spoken words are asynchronous with the accompanying face (Hollich, Newman, & Jusczyk, 2005). When speech alone is presented in the absence of a speaking face, then learning and recognizing words that have become familiar in sentences emerges at 12 months of age but not earlier at 10 or 11 months (Depaolis, Vihman, & Keren-Portnoy, 2014). The evidence from Hollich et al. (2005) and Depaolis et al. (2014) taken together, suggests that by 10 months, infants expect typical word learning contexts to be naturally multisensory. Therefore, they benefit from seeing and hearing speaking adults in word learning contexts, but fail to learn words or recognize the words in atypical contexts when they only hear the words spoken but do not see a live speaker. By 12 months, however, they do learn and recognize words in sentences that are less typical, when they merely hear the words in the absence of a live

speaker. In essence, research has touted the benefits of infants' listening to caregivers' conversation and caregivers' listening to infants' vocalizations (e.g., Zimmerman, Gilkerson, Richards, Christakis, Xu, et al., 2009). The emphasis in this volume, in contrast, has been on infants' attention to far more than the auditory properties of communication alone. The manifold benefits of infants' attention to the multisensory properties of interactions that caregivers provide for their infants through their speech simultaneous with visual actions using objects and even touch cannot be emphasized enough for successful word learning to occur in natural everyday play contexts. Thus, for instance, Igualada, Bosch, and Prieto (2015) found that the language development of toddlers at 18 months is strongly associated with the multisensory experience that caregivers provided to them when they were 12 months of age. Complementing these findings, discussed in chapter 4, a number of studies pointed to the importance of this multisensory experience for word learning earlier around 6- to 9 months (e.g., Gogate et al., 2006; Nomikou et al., 2017).

It is important to note, however, that whereas this multisensory experience is salient to infants and facilitates novel word learning during the first year, its salience declines considerably during the second and subsequent years as infants begin to predominantly rely on other strategies for learning novel words. Hence, whereas 8-month-olds learn novel word-action relations in the presence of multisensory redundancy (temporal synchrony, common tempo and rhythm) when no social cues are provided, 14-month-olds fail to learn the same word-action relations under the very same conditions (e.g., Gogate & Maganti, 2017). Reciprocally, caregivers name objects and actions using multisensory redundancy in the form of temporal synchrony far less frequently to 21- to 30-month-old toddlers relative to caregivers of 6- to 9-month-old infants, a phenomenon observed across western and non-western cultures (Gogate et al., 2000; Gogate et al., 2015).

Finally, it can be predicted that the specific strategies that caregivers or infants use at any given time is contingent upon the word learning context in which they find themselves. For example, a toy object in the hand, such as a ball, affords both space and time manipulations by a caregiver, and the use of gestures such as showing, to evoke joint engagement between the caregiver and infant. In contrast, an object flying far away in the air, such as an airplane, only allows pointing to a far-away object to evoke joint engagement between the caregiver and infant. Nevertheless, children come to learn, over time, words for things that are near and far as they become adept at engaging with their caregivers in a variety of naming contexts. In light of these existing variations, the specific strategies that both infants

attend to and caregivers employ in word learning contexts at any given time deserves careful assessment prior to advocating intervention strategies for vocabulary development throughout childhood.

Cross-cultural variations in word learning

Across cultures, typically, children learn many nouns, verbs and words that modify these classes of words such as adjectives and adverbs during the course of the first three years of life. However, as discussed in Chapter Seven, the rates at which infants learn nouns versus verbs vary across cultures based on their language environment. When children learn a noun-dominant language such as English (containing a greater proportion of nouns relative to verbs), starting around 10 months of age, "nouns continue to dominate until a child has acquired about hundred words, when the proportion of verbs begins to increase slowly with a proportional decrease in nouns" (Gunter & Koenig, 2011, p.80). Prior to 16 months, this noun-dominance in early vocabularies is far from universal (Nelson, Hampson, & Shaw, 1993). Thus, when children learn a verb-dominant language (with a greater proportion of verbs relative to nouns), infants show a preponderance of verbs in their early vocabularies. For example, infants of 6.5 to 12.5 months from Telugu (a Southern-Indian verb-dominant language) speaking homes comprehended and complied with their mother's verbally requested actions such as 'give' and 'take' far more and at much younger ages than infants from British-English speaking homes (Reddy, et al., 2013). As another example, when their first 10 words were examined (Tardif et al., 2008), not only did Mandarin (average number of words = 4.8, *SD* = 12.7) and Cantonese (average words = 7.0, *SD* = 4.6) learning infants produce far more verbs than English learning infants (average words = .7, *SD* = 4.3), they also produced verbs more readily later on (Chinese, Tardif, 1996; Korean, Choi, 1998; Choi & Gopnik, 1995; Tamil, Sethuraman, & Smith, 2010).

Cross-linguistic variations in the relative frequency of nouns or verbs in the language spoken at home profoundly influence the rate at which children learn to comprehend as well as produce nouns and verbs during the course of their language development. For example, at 14 and at 18 months, English learning infants do not map words onto actions, whereas at both ages, Chinese (Mandarin) learning infants mapped the same words onto actions. However, the English learning infants mapped words onto objects at 18 months, but not at 14 months. In contrast, the Chinese-learning infants did not map the words onto objects at both ages (Chan, Tardif, Chen, Pulverman, Zhu, & Meng, 2011). However, Katerelos et al. (2011) report

successful mapping of both nouns and verbs onto referents by 18- to 20-month-old English, French and Japanese learning bilinguals regardless of language background.

Cross-linguistic variations also have profound implications for children learning a second language that does not match with their first language in their noun or verb dominance. For example, consider the cases of children born to immigrant parents around the world (e.g., Vietnamese, a language that is verb dominant) who are not fluent in the dominant language of the country (e.g., the United States where noun dominant English is predominantly spoken) to which they have recently immigrated. It is conceivable that children who are learning a second language that does not fit with the verb dominance pattern of their first language would find it harder to learn the second language relative to children who are learning a second language that fits with the verb- or noun dominance pattern of the first language. Further research must empirically investigate whether second language learning is influenced by the dominance of specific word classes such as nouns and verbs and, more importantly, incorporate the possible differences in learning of nouns and verbs when providing early language intervention.

Word comprehension and production

What is the precise relation between infants' word comprehension and word production? How do infants get from simply understanding words and their meaning to producing words? Word comprehension is necessary but not sufficient for word production to occur. Some studies that have examined the relation between toddlers' comprehension and production suggest that, in their second year, infants start to produce words at the same time when they understand at least a hundred words approximately (Smith, 2002). Others have focused on multiple environmental factors that promote the beginnings of word production in the infant. Roy et al. (2015) showed, for example, that the quantity of speech addressed to an infant is not the best predictor of speech production. Rather, the quality of speech addressed to an infant is a better predictor of speech production. They also stress the significance of caregivers providing infants with a multimodal context in order for word production to emerge–

> "….. words used in distinctive spatial, temporal, and linguistic contexts are produced earlier, suggesting they are easier to learn. These findings support the importance of multimodal context in word learning……" (Roy et al., 2015, p.12663)

These findings suggest that the very same strategies that assist infants to learn word-world mappings, such as the naming of objects or actions in distinct spaces, or uttering words in temporal synchrony with hand held objects, also assist in their word production.

Additionally, learning to produce words utilizes pre-language abilities such as the extent and quality of the babble infants produce prior to their first word production (McGillion, Herbert, Pine, Vihman, Depaolis, Keren-Portnoy, & Matthews, 2017). At the same time, it utilizes a number of general-purpose abilities (Bates, 1993). One such important ability that aids in language production is imitation. Infants, at 6 months, are more likely to imitate adults' vocalization if (1) infants look at upright faces, (2) they look at the adult's mouth, and (3) the adult also looks at the infant while vocalizing (Imafuku, Kanakogi, Butler, & Myowa-Yamakoshi, 2019). In chapter 5, it was reported that children are more likely to use the same gestures as their parents (Rowe & Goldin-Meadow, 2008). This type of gesture adaptation across caregivers and infants also holds true for parents' and children's word use. Two- to 3-year-old children learn and produce the same word-frames as used by their mothers (e.g., Can you . . ., Here's . . ., or Let's . . .), and the children's frequency of use of such frames correlates with their mothers' frequency of use of those frames (Cameron-Faulkner, Lieven, & Tomasello, 2003). Thus, for example, repetition of words by an adult in successive sentences, a well-established feature of child-directed speech, rather than the words widely distributed across a conversation, facilitates the learning of novel object names and increases vocabulary in 2-year-old infants (Schwab, & Williams, 2016). This is because repetition of words in successive sentences likely reinforces the words in infants' memory and promotes word production via imitation. These findings, taken together, establish that imitation is a robust general-purpose ability for facilitating young children's word production and vocabulary growth.

Another general-purpose cognitive ability that plays an important role in word learning is young children's understanding that adults typically name things that are novel during discourse, and that it is the adult who determines what is novel (Akhtar, Carpenter, & Tomasello, 1996). Thus, for example, regardless of whether a group of 24-month-olds had first explored novel objects in the presence or absence of an adult, the toddlers learned the novel names for the objects so long as the objects were novel to the adult who named it.

Where Do We Go From Here?

In light of clearly established general-purpose abilities, such as imitation, and environmental factors such as socioeconomic status mediating word learning (see subsection below), it is entirely feasible to alter the course of infants' vocabulary development and language outcomes, and to facilitate preschool language readiness by changing early caregiver and infant language behaviors. Some of the behaviors that potentially enhance word learning are described below.

Responsive parenting and children's word learning

Positive changes in parents' and children's responsiveness have major positive implications for early social, cognitive, language and communication outcomes (e.g., Landry, Smith, Swank, & Guttentag, 2008). Owing to the influence of responsive parenting, as was discussed earlier in the chapter, during parent-child interactions, when the teaching context was disrupted by a momentary telephone call, children did not succeed in learning a new word (Reed et al., 2017). A wealth of research has established that responsive interactions between parents and children result in children learning a greater number of words. Thus, when mothers use responsive communication styles (i.e., positive affect while vocalizing in infant-directed speech) for their infants, between 7 and 11 months of age, they are positively associated with toddlers' vocabulary development at 18 and 24 months (Dave, Mastergeorge, & Olswang, 2018). As another example, Cartmill, Armstrong, Gleitman, Goldin-Meadow, Medina et al. (2013) reported, from recordings of parent-infant interactions at 14-18 months, that the quality of parents' use of visual context during language use to infants predicts children's vocabulary three years later at 54 months. Adults were asked to guess the parents' words during interaction from muted videos based on the visual context in which the parents' words were spoken. Parents who used a richer visual context during object naming to infants at 14-18 months (e.g., showed objects more often in the infants' line of sight) also had children with greater vocabularies at 54 months even after controlling for the quantity of parents' words used per minute. As an example of children at-risk for language delay, Landry, Smith, and Swank (2006) demonstrated in a study, following very-low birth weight preterm versus term born children from ages 1 to 8 years, that the children with greater language growth also had mothers who were able to maintain their child's attention and interest for sustained periods of time during interaction. We can conclude from these findings that the extent of

children's early vocabulary varies greatly and is highly dependent on a rich visual and auditory context with a number of nonverbal cues from which infants can learn a context-appropriate word. Additionally, from earlier chapters (Chapter 2), it is clear that responsive parents typically modify their speech in many ways, including their prosody, to highlight novel words in the speech stream, providing a rich auditory context.

In cases of sensory impairment, such as in hearing-impaired children, the visual sensory modality dominates relative to the auditory modality and children are known to depend more heavily on the visual context for word learning. Houston, Chen, Monroy & Castellanos, (2020) note for instance that–

> "Deaf infants have full access to the visual, tactile, and olfactory information that allows them to form concepts of objects, actions, smells, textures, and other semantic categories in the world. Until they receive CIs [cochlear implants], they form multisensory representations of concepts (e.g., the way mom looks, acts, smells, and feels), without the sounds associated with those concepts." (Houston et al., 2020, p.131)

To compensate for their children's auditory deprivation, once again, responsive parents of the hard of hearing children used spoken words simultaneous with touch more often than parents of hearing-normal children (11-43 months; Abu-Zhaya, Kondaurova, Houston, & Seidl, 2019), but used temporal synchrony between their spoken words and visual object motions less often relative to parents of hearing-normal children (12-37 months; Chen, Castellanos, Yu, & Houston, 2019). However, even in cases where children are initially auditorily deprived due to hearing impairment, and later receive a cochlear implant, post-implant provision of synchrony between spoken words and object motion facilitates word mapping and comprehension (e.g., Bergeson, Pisoni, & Davis, 2005).

In cases of visual impairment, once again, responsive caregivers provide communicative input predominantly to the tactile and auditory senses given that these children are known to rely more heavily on their hearing and tactile senses to learn language. For instance, mothers of visually-impaired infants in the 1- to 2-word stage of language production are far more likely to name and describe objects that their toddlers are already touching or hearing (see numerous examples in Andersen, Dunlea, Kekelis, 1993).

Further implicating the positive effects of responsive parenting, children's vocabulary by age three is directly correlated with parents' quantity and quality of language, mediated by the parents' socioeconomic

status (SES) and education-level (e.g., Hart & Risley, 1995; Hart, Newell, & Olsen, 2003; Hoff, 2013). Children from low-SES households show on average a 30-million word deficit by age three years relative to children from high-SES households. Parental socio-economic status is an important environmental factor that not only predicts children's word production, but also predicts their ability to build a robust vocabulary later on (Shavlik, Davis-Kean, Schwab, & Booth, 2020). That is because parents with greater education and income levels, relative to parents with lower education and income levels, tend to talk more to their children and ask open-ended *wh*-questions (e.g., where is the ____?; What is its name?) more often, allowing more opportunities for children to talk. In contrast, parents of lower-socioeconomic status tend to use a greater number of directive utterances rather than open-ended *wh*-questions (Hart & Risley, 1995). The negative impact of such disparities on vocabulary and language processing skills can be observed in children from low-income households as early as 18 months (Fernald, Marchman, & Weisleder, 2013). They are also evident in the brainwave activity of infants when presented with words in the first two years of life (Noble et al., 2015), and in the language of adolescents of 13- to 14-years (Spencer, Clegg, & Stackhouse, 2012). The carryover effects of family socioeconomic status on children's development can be observed across multiple generations of children and adolescents (Sohr-Preston, Scaramella, Martin, Neppl, Ontai, & Conger, 2013).

Researchers have suggested general strategies to assess and address the 30-million word gap in young children (Cartmill, 2016; also see Final Thoughts section of the present chapter below). For example, simply changing bilingual parental and children's attitudes (from negative to positive) about the benefits of learning a second language enabled greater vocabulary outcomes in an urban group of children (Souto-Manning, 2006). Far more fine-grained intervention strategies must be implemented, however, at much earlier time-points during language development to mitigate the cascading effects of language delay seen later during infancy and early childhood. For example, as a precursor to implementing such early language intervention strategies, caregiver-infant interaction research has shown that important aspects of maternal naming strategies, such as their use of *showing* gestures with objects simultaneous with novel object naming are well adapted to typically developing term infants' word learning, particularly in the second half of the first year (Gogate, 2020). That is, mothers who named the novel objects simultaneous with *showing* object motions during play also had infants who, at 6- to 9 months, looked more often to the word-matched objects than the mismatched objects during a subsequent test, showing word learning. However, at 12 months, although

the same mothers used object motions simultaneous with novel object naming far less often, showing adaptation, the infants looked significantly longer at the mismatched object, also showing learning. Thus, we can conclude that they relied far less on synchrony for learning the word-object relations at 12 months than at 6- to 9 months. In stark contrast, this same level of maternal adaptation during object naming to infants' word learning ability was not evident in interactions between mothers and their premature infants, at 6- to 9 or 12 months, who failed to show any learning of the word-object relations. These findings, taken together, speak to the positive effects of strategically matching parent teaching styles to infants' specific word learning level and needs.

Similarities between Natural Parenting and Early Language Intervention Strategies

There are strong similarities between natural parenting strategies, including speech, language and gesture use, and teaching strategies used by teachers and intervention specialists (Dunst, Raab, & Trivette, 2012). Therefore, the plethora of strategies highlighted in this volume would serve to enhance children's word learning, both at home with parents and outside the home in early childcare and preschool settings with teachers. For example, Guevara, Moreno-Llanos, and Rodríguez (2020) have shown that early childcare teachers play a major role in infants' learning and modulation of gestures such as 'show' and 'give' using objects during their first year. Similarly, as discussed in chapter 5, a number of studies have shown that mothers play a critical role in educating their infants in the first year about novel objects and their names using showing (Matatyaho & Gogate, 2008; Gogate et al., 2013) as well as 'give' and 'take' (Reddy et al., 2013) gestures.

As another case in point, Landry and colleagues showed that responsive early childcare and teaching practices of professionals and educators enabled the maintenance of infant attention to specific objects of interest for longer periods of time in the "responsive early childhood program", and yielded positive developmental outcomes for toddlers at risk for developmental delay, including vocabulary (Landry, Zucker, Taylor, Swank, Williams, et al., 2014). Similarly, responsive parent teaching during social interactions with their toddlers contributed to better developmental outcomes for the toddlers, including greater vocabulary development (Landry, Smith, Swank, & Guttentag, 2008; also Landry, Smith, & Swank, 2002).

These findings, taken together, suggest that there are similarities between natural parenting strategies, including speech, language and gesture use and teaching strategies used by teachers and intervention specialists. To mitigate language delays, therefore, caregivers in early childcare settings can be trained on naturally occurring and optimal parenting skills and strategies for teaching language to benefit children in the early childcare settings.

Final Thoughts

Several early language intervention programs have successfully utilized an interactionist framework for enhancing all round development including enhancing vocabulary in young children at risk (e.g., Whittmer & Petersen, 2017; Landry et al., 2014). Many have focused exclusively on early intervention programs to enhance preschoolers' vocabulary also utilizing an underlying interactionist framework (Hassinger-Das, Ridge, Parker, Golinkoff, Hirsh-Pasek, & Dickinson, 2016; Kamil, & Hiebert, 2005; Mendelsohn, et al., 2011; Toub et al., 2018). More recently, in a special issue of the Early Childhood Research Quarterly, Walker and Carta (2020) reported on and reviewed several language intervention programs to bridge the 30-million word gap, that range from improving parent-child interaction through book reading (Troseth et al., 2020), to professional development of early childhood educators and teachers (Wasik & Hindman, 2020). In the special issue, in concurrence with the very purpose the present volume is designed to serve, Walker, Sepulveda, Hoff, Rowe, Schwartz et al. (2020) highlight many gaps in extant language interventions. Among these numerous gaps, two are particularly salient to the main purpose of the present volume: there remains an immense need for (1) language interventions targeting children at much younger ages; and (2) measures that are sensitive to intervention. First, they note that in spite of the evidence that language interventions implemented at early ages greatly benefit children and families, there remains a scarcity of early intervention programs for children under age 3 years. In addition, they underscore the dire need for measures that are sensitive to intervention change and inform practice (Walker et al., 2020).

Early language intervention research and practice currently using the interactionist framework have yet to utilize many of the strategies or measures for enhancing word learning specified in the present volume. To mitigate the 30-million word gap in children stemming from an impoverished home-language environment, this volume provides a detailed account of the specific properties of infant-caregiver interaction that

promote word learning. The manifold strategies for vocabulary building early in infancy, based on the state-of-the art research discussed here, if implemented in early intervention research, should enable vocabulary building starting from the ground up during infancy. Such implementation should assist in mitigating language delays, and in bridging the word gap in children at risk for language delay, and in turn, enable children to more fully benefit from language and literacy instruction they will receive in school.

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