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Adapting Human Thinking and Moral Reasoning in Contemporary Society

Hiroshi Yama and Veronique Salvano-Pardieu

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Table of Contents

Section 2
Reasoning in the Modern World

Section 3
Education and Policy

Detailed Table of Contents

work of Gilligan on moral orientation and the difference observed between men and women. Then, the authors will analyze underlying structures of moral judgment in the light of the Dual Process Theory with two systems: system 1: quick, deontological, emotional, intuitive, automatic, and system 2: slow, utilitarian, rational, controlled, involved in human reasoning. Finally, the model of Dual Process Theory will be confronted with data from moral judgment experiments, run on elderly adults with Alzheimer's disease, teenagers with Autism Spectrum Disorder, and children and teenagers with intellectual disability in order to understand how cognitive impairment affects the structures and components of moral judgment.

What does "reasoning" mean? What is its purpose? And, how does it function? This chapter defines reasoning and the distinction between deductive and inductive reasoning. Secondly, the argumentative theory of reasoning proposed by Mercier and Sperber (2011) is presented to understand the purpose of the reasoning. This theory postulates that its function is to convince others and to evaluate information received when someone tries to convince another. Thirdly, the authors focus on the intervention model of reasoning developed by Evans (2011) to try to understand how the reasoning functions. This model is derived from dual-process theories and proposes a distinction between two types of processing in reasoning. The last part explains the importance of considering the emotional factor in the study on the reasoning process.

This chapter investigates if System 2 (analytic system) can revise or suppress the negative outputs of System 1 (intuitive system) by natural experiment in history. Two periods are picked up in this chapter: the 17th century when there was a decline in war, torture, cruel punishment, and religious persecution, and the time after World War II when there has been a decline in war, genocide, and violence with growing awareness of human rights. In short, the outputs associated with strong emotion are less likely to be revised, and an effective way for revision is to use a story to trigger the theory of mind in System 1. This is also discussed in the frame of distinction between deontic moral judgment and utilitarian moral judgment. Finally, it is proposed that a good story should be elaborated by System 2 and be prevailed so that it arises emotions (sympathy) of System 1 and drives people for the better-being future.

Section 2
Reasoning in the Modern World

People sometimes hold irrational beliefs even when empirical evidence obviously debunks claims central to beliefs. This chapter reviews empirical studies exploring underlying psychological processes of holding empirically suspect beliefs with a particular focus on belief in pseudoscience. The author explains empirical findings from a dual process view of thinking. Recent studies show individuals with higher analytic tendency exhibit more ideologically polarized reasoning than those with lower analytical tendency. These results suggest a significance of motivated reasoning in order to fully understand the psychological mechanism of everyday beliefs. Future research suggestions emphasize remaining questions, such as a developmental time course of, a cultural diversity of, and evolutional origins and functions of the belief in pseudoscience.

This chapter explains how laypeople generate and evaluate explanations. Traditionally, deliberate processing is assumed to be involved in generating and evaluating explanations. However, the author proposes two stages account for causal attribution and explanation to explain how laypeople generate and evaluate explanations quickly: a semi-autonomous processing stage which is primarily dependent on the lexical information of the verb, and a deliberate processing stage that takes many factors into account. The author proposes that verb types play an important role in determining the type of explanation and calls it verb cue hypothesis. In addition, the author proposes that verb cue hypothesis works as a cognitive shortcut that comprises the first stage of the two-stages account. Empirical evidence for the verb cue hypothesis was found in studies on causal attribution and explanation type preference.

In the process of human evolution, the biggest adaptive problems have been how to maintain a group and how to rise in rank in a group hierarchy. If an adaptive problem is solved, the probability the solver will survive and success in reproduction rises. Laugh and laughter is discussed in the frame that it has been used to solve

the adaptive problem in this chapter. The trigger of laughter is the cognition of a discrepancy. The discrepancy is the difference between what is expected and the actual state. A discrepancy cannot be serious to cause laugh and laughter. If it is implicitly expected to be resolved, then it is likely to arise a laughter with positive feeling. When laughter is shared by some people, it functions to link them with friendly relationship. On the other hand, the laughter becomes derisive (ridicule) when the discrepancy is between a social norm and an actual behavior. The ridicule functions to one's supremacy over the target individual. This function has been adaptive in the society of dominance hierarchy.

Society is facing uncertainty on a multitude of domains and levels: usually, reasoning and decisions about political, economic, or health issues must be made under uncertainty. Among various approaches to probability, this chapter presents the coherence approach to probability as a method for uncertainty management. The authors explain the role of uncertainty in the context of important societal issues like legal reasoning and vaccination hesitancy. Finally, the chapter presents selected psychological factors which impact probabilistic representation and reasoning and discusses what society can and cannot learn from the coherence approach from theoretical and practical perspectives.

This chapter presents a research on moral judgment with pre-school and first-year school children. This research promotes, through the use of mimes and role playing, the development of moral reasoning and its components such as Theory of Mind

and Perspective Taking of the other. The authors wanted to develop in 5-year-old children the ability to understand the intent of the other in social interactions and moral judgment. According to the authors, if children learn taking into account the perspective of the others through role playing, they will improve their cognitive abilities involved in social interactions and will be more capable of developing Theory of Mind. This will lead them to adopt a more pro-social behavior. This research paves the way to new pedagogical perspectives by showing that developing mime, role playing, and argumentation with young children to explain conflict, impacts the "intention evaluation system", the theory of mind and system 2 which is involved in rational and controlled reasoning.

Chapter 10

This chapter shows the importance for teachers to enter into a truly reflexive activity and to make it the main aspect of their professional activity. The author describes ways teachers can regain control over the activity of thinking and adapt their modes of reasoning to educational situations by developing control over the transition from system 1 to system 2. The aim is to consider the conditions for developing decision-making procedures, both reflexive and collective, when faced with complex situations (particularly crises), based on a deliberation rooted in a logic of inquiry.

Chapter 11

This chapter introduces a construction approach to logic education by explaining why such an approach is needed and how it should be implemented. The chapter is divided into two parts. The first part argues that conventional logic education cannot teach people how to make a practical use of logic because what people commonly learn from conventional textbooks of logic can hardly correspond to the ordinary way of reasoning. The second part highlights how the construction approach can be integrated into people's ordinary way of reasoning by being practical and constructive in helping people use logic in what they do, such as writing an academic paper. It presents a general framework about how a logical relation can be constructed from scratch, and the three major steps of the construction.

Preface

It is seldom that researchers who are interested in reasoning, knowledge, and belief (cognitive scientists) discuss modern times such as how humans have developed contemporary science, industry, social and economic systems, legal and educational systems, and social norms, including the sense of morality.

Some scientists have taken a "big history" approach to describe the history of Homo Sapiens, pointing out many factors that are responsible for the construction of the modern world. In its original sense, the term "big history" meant an academic discipline that examines the history that started from the "big bang" of the universe to the present day. However, the term is also used to refer to human evolution and cultural development from the era of the earliest humans to the contemporary world in the fields of psychology and anthropology. For example, Jared Diamond pointed out the geographical and ecological factors (e.g., wild plants and animals which were suitable for domestication) to explain the unbalanced development of civilization in his book "Guns, Germs, and Steel: The Fates of Human Societies" published in 1997. It has inspired many researchers who followed this approach. For example, Yuval Noah Harari surveyed the history of humankind from the evolution of archaic human species in the Stone Age up to this century in his book "Sapiens: A Brief History of Humankind" published in 2011. The book records the great history behind the development of natural sciences.

What kinds of contributions could researchers who are tackling with human reasoning, knowledge, and cognitive science make following the big history approach? Obviously, it is human intelligence, including reasoning ability that has created the sciences, industries, and social systems and achieved modern prosperity. It is worthwhile that researchers who are studying human abilities discuss how the contemporary world has been shaped by human intelligence. Actually, those who take the perspective of human evolution have already published their ideas. For example, Steven Pinker showed the major historical declines of violence including

war, genocide, and murder in his book "The Better Angels of Our Nature" published in 2011. He argued how humans have drastically decreased violence in our long history, and how the awareness of human rights grew after World War II (for example, a decline of prejudice and discrimination against colored people, females, and minorities). The awareness of human rights is strongly related to human morality.

Dual process theorists suppose two kinds of subsystems one of which processes heuristic thought (System 1) and the other processes analytic thought (System 2). It is assumed that System 2 has supported the development of civilization. Jonathan Evans stated that his primary motivation for proposing a dual process theory was to resolve the paradox that humans are able to, on the one hand, show excellent intelligence to create logic, political and economic systems, and many advanced technologies, but on the other hand, are susceptible to many biases and often make errors on psychological tasks in his book "Bias in Human Reasoning: Causes and Consequences" published in 1989

For example, Steven Mithen introduced the term "cognitive fluidity" and argued that it was about 50,000 years ago when the cognitive fluidity combined with modular units in human cognitive architecture that caused the Cultural Big Bang in his book "The Prehistory of the Mind: A Search for the Origins of Art, Religion and Science" published in 1998. The cognitive fluidity was achieved by System 2.

The frame of dual process theory is a good tool to discuss how Homo Sapiens have constructed modern society and the world generally and how they can be adaptive in them. Although all of the contributors of this book are not dual process theorists, each of them explicitly and/or implicitly assumes such distinctions or contrasts in human architecture as dual process theorists would conceive. In short, the modern industrial world has been constructed mainly by System 2 so that Homo Sapiens are more adaptive than they used to be.

However, people are surrounded by too much information (or uncertainty in other words) in the environment that is completely different from the one where their brains have evolved. This problem is shared by all the authors of this book as an important issue.

INTRODUCTION OF EACH CHAPTER

Chapters in this book are grouped into three sections. There are our chapters in the first section, which primarily focuses on dual process, reasoning, and morality.

The idea of the existence of duality in the functioning of the human mind is not new: for some psychologists, this is due to the existence of two types of cognitive process, heuristic and analytic. The former is influenced by the individual's beliefs,

while the latter analyzes the validity of arguments and justifications. Roger Fontaine and Valérie Pennequin cover this duality from a critical perspective by exploring its ecological validity in Chapter 1. It is examined in relation to the principles of the Darwinian theory of evolution and presents the advantages of the alternative model of argumentative theory. They present in more detail recent models of moral reasoning to illustrate what are believed to be the limitations of the dual-process models of cognition.

Véronique Salvano-Pardieu, Leïla Oubrahim, and Steve Kilpatrick present research on moral judgment from the beginning of the 20th century to the present day in Chapter 2. They analyze the underlying structures of moral judgment from the perspective of the Dual Process Theory. The model of Dual Process Theory is confronted with data from moral judgment experiments, run on elderly adults with Alzheimer's disease, teenagers with Autism Spectrum Disorder and children as well as teenagers with intellectual disability in order to understand how cognitive impairment affects the structures and components of moral judgment.

Elodie Tricard and Célia Maintenant raise questions in Chapter 3: what does "reasoning" mean? What is its purpose? And, how does it function? They introduce its definition and the distinction between deductive and inductive reasoning for the first question. For the second question, they postulate that the purpose of reasoning is to convince others and to evaluate information received when someone tries to convince us (the argumentative theory). Thirdly, they focus on the intervention model of reasoning and propose a distinction between two types of processing in reasoning. They also consider the role of emotion in the dual process reasoning model.

Hiroshi Yama examines if System 2 (the analytic system) can revise or suppress the negative outputs of System 1 (the intuitive system) by means of a natural experiment in history in Chapter 4. He proposes that the outputs of System 1 associated with strong emotion are less likely to be revised, and an effective way for revision is to use a story to trigger the theory of mind in System 1. This is also discussed in the frame of distinction between deontic moral judgment and utilitarian moral judgment.

The shared topic of the next four chapters is human reasoning in the modern world.

It is obvious that people have come to believe in pseudoscience less than they once did. Yoshimasa Majima discusses why people believe in pseudoscience or disbelieve in science in the framework of the dual process theory in Chapter 5. He introduces surprising recent studies to show that higher analytic tendency exhibits ideologically polarized reasoning than those with less-analytical tendency.

We live in a rapidly changing environment in this modern society, and we constantly receive new information due to the development of information technology. Hence, we have to quickly find causes and understand what is happening in order to survive.

Kyung Soo Do argues that people need a system that has two processing stages for causal attribution and understanding and proposes a skeleton of two processing stages that account for causal attribution and understanding: A semi-autonomous lexical based processing stage that works fast, and a deliberate processing stage that takes many factors into account in Chapter 6.

Hiroshi Yama discusses laugh, laughter, and humor as the solution of adaptive problems to maintain people's social group and to rise in rank in their group hierarchy in Chapter 7. They are important in contemporary society for human relationships and have an evolutionary origin. Laugh and laughter are not only used for friendly relationships, but also used as ridicule or insult. Ridicule functions to provide supremacy for one individual over their target, and thus this function has been adaptive in society as part of the dominance hierarchy.

Contemporary society is characterized as facing uncertainty on a multitude of domains and levels: usually, reasoning and decisions about political, economic, or health issues have to be made under uncertainty. Niki Pfeifer and Andrea Capotorti present the coherence-approach to probability as a method for uncertainty management and show selected psychological factors which impact on probabilistic representation and reasoning and discuss what society can and cannot learn from the coherence of theoretical and practical perspectives in Chapter 8.

The next four chapters propose recipes (via education and policy) in contemporary society.

Véronique Salvano-Pardieu, Manon Olivrie, Valérie Pennequin, and Briony Pulford investigated moral judgment with pre-school and first year school children and show the results in Chapter 9. According to them, within the framework of Theory of Mind, when children learn how to take into account the perspective of others through role playing, they improve their cognitive abilities involved in social interactions and are more capable of developing Theory of Mind. This also leads the children to adopt more pro social behavior. This research paves the way to new pedagogical perspectives by showing that developing mime, role playing and argumentation with young children to explain conflict, has an impact on the "intention evaluation system", theory of mind and system 2 which is involved in rational and controlled reasoning.

The purpose of Chapter 10 is to show the importance for teachers of a truly reflexive activity and to make reflection the main aspect of their professional activity. Sébastien Pesce describes the ways in which teachers can regain control over the activity of thinking and adapt their modes of reasoning to educational situations by developing control over the transition from system 1 to system 2 of Dual Process Theory.

Logic, logical thinking, and its education are one of the key components of the modern industrial society. Wai Ling Lai and Kazuhisa Todayama introduce a construction approach to logic education by explaining why such an approach is needed and how it should be implemented in Chapter 11. They argue that conventional logic education cannot teach people how to make practical use of logic because what people commonly learn from conventional textbooks does not correspond to the ordinary way of reasoning. They highlight how the construction approach can be integrated into people's natural way of reasoning by being practical and constructive in helping people use logic in what they do, such as writing an academic paper.

It is very important to manage intellectual capital as part of knowledge management in modern society. The Ministry of Education in the United Arab Emirates is a federal organization whose environment has been studied to identify its model, methods, and tools for measuring, developing, and managing intellectual capital. In Chapter 12, Shafiz Affendi Mohd Yusof, Sendeyah Rahmah Al Hantoobi, and Kiren Jackie concluded that there is genuine interest within the ministry to develop its intellectual capital and invest in its different dimensions. Their study offers several contributions, the most important being the process for measuring, developing, and managing intellectual capital.

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Section 1

Dual Process, Reasoning, and Morality

Chapter 1
Dual Models Argumentative Theory and Moral Reasoning

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ABSTRACT

The idea of the existence of duality in the functioning of the human mind is very old: for some psychologists, this is due to the existence of two types of cognitive process, heuristic and analytic. The former is influenced by the individual's beliefs, and the latter analyzes the validity of arguments and justifications. This chapter examines this duality from a critical perspective by exploring its ecological validity. Thus, the duality will be examined in relation to the principles of the Darwinian theory of evolution and presented the advantages of the alternative model of argumentative theory. Authors present in more detail recent models of moral reasoning to illustrate what they believe are the limitations of the dual-process models of cognition.

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INTRODUCTION

The idea of the existence of duality in the functioning of the human mind is very old. Thus Plato (The Republic, Book VI) contrasted a human world that he described as relative, without absolute truth, corruptible (biased), in short natural, with the world of ideas and models that would be absolute and allow us to achieve truth and the universal. Through anamnesis human beings can step outside the physical world to attain the absolute truth of the world of ideas. It is remarkable how much this Platonic dualism has influenced and still influences philosophical and scientific thought. Dualism is closely associated with the thought of René Descartes (1641), which holds that the mind is a nonphysical substance. Mind–body dualism, is a view in the philosophy of mind that mental phenomena are non-physical or that the mind and body are distinct and separable. *Res extensa* and *res cogitans* are mutually exclusive and this makes it possible to conceptualize the complete intellectual independence from the body. *Res cogitans* is also referred to as the soul and is related by thinkers such as Aristotle in his. On the other hand, *res extensa*, are entities described by the principles of logic and are considered in terms of definiteness. Due to the polarity of these two concepts, the natural science focused on *res extensa*.

The emergence of a scientific model of duality is associated with the development of probability theory by mathematicians in the 17th century. It was then considered as a way for gamblers to rid themselves of their illusions, beliefs and emotions and adopt rational strategies when making bets. One of the chapters in the philosophical essay on probability by Pierre-Simon de Laplace (1796), the great French mathematician, is entitled "*Des illusions dans l'estimation des probabilités*", and it describes the famous "gambler's fallacy". This concerns the fact that, in the coin toss game, if the coin comes up tails several times in a row, many people think that the next throw is increasingly likely to come up tails. The reasoning is false but is very seductive, comparable to the effects of an optical illusion. Since then, this fallacy has been the subject of systematic research (Tversky & Kahneman, 1971; Ayton & Fisher, 2004). Kahneman suggested that perceptual biases (optical illusions) are to perception what cognitive biases are to reasoning.

In line with the Greek philosophers, this duality is fundamentally based on the conviction that the laws of thought respect the rules of formal logic. In 1854, one of the pioneers of modern logic, George Boole, published a book entitled "The laws of thought", considered by some psychologists as a handbook of general cognitive functioning. For example, Piaget (1977-1985) considered the mathematical theory of Poincaré groups (1898) as a model of cognitive structures. But the full title of

Boole's book is much more precise: "An Investigation of the Laws of Thought on Which are Founded the Mathematical Theories of Logic and Probabilities". Boole therefore confined his laws of thought to the mathematical field, without raising the question of whether these laws can be applied to non-mathematical tasks of daily life. But according to dual-process models, we are mathematicians whose skills are hindered by our beliefs and illusions.

In this chapter, we examine this duality from a critical perspective by exploring its ecological validity. Thus, we will examine it in relation to the principles of the Darwinian theory of evolution and present the advantages of the alternative model of argumentative theory. We present in more detail recent models of moral reasoning to illustrate what we believe are the limitations of the dual-process models of cognition.

Intuition Is Reason in a Hurry. – Holbrook Jackson

Researchers in the psychology of reasoning have developed many dual-process models to explain poor human performance in logical problem-solving tasks. One of the most famous is Wason's selection task (1960, 1966), in which participants are asked to test the condition of the proposition that if a card has a vowel written on one side, then it has an even number written on the other side. To confirm the rule, participants must turn over as few cards as possible. It appears that only 10% of participants are successful, and even less when they are asked to justify their answer.

For some psychologists (Wason & Evans, 1975; Evans, 1989; Stanovich & West, 2008; Kahneman, 2011), this is due to the existence of two types of cognitive process, heuristic and analytic. The former is influenced by the individual's beliefs, and the latter analyzes the validity of arguments and justifications. While the heuristic system is often adaptive, it leads to many reasoning errors, whereas the analytical system uses rules to analyze the elements of a statement or decision in order to find the correct answer. These two systems are based on different types of rationality. The heuristic system is used to think, speak, reason, decide and act appropriately to achieve personal objectives without seeking coherence. The analytical system, on the other hand, takes a hypothetical-deductive approach to think, speak, reason and make decisions, producing normatively correct solutions (Evans & Over, 1996). The heuristic system is used when making decisions in situations that have become normal as a result of evolution (in the Darwinian sense) or development, whereas the analytical system is used to make decisions in new situations.

Three principles govern the operation of the two systems: singularity, satisficing and relevance. The singularity principle states that hypothetical-deductive processes operate serially and that people can only process one hypothesis or mental model at a

time. This principle derives from the limitation of the processing capacities inherent in short-term and working memory. Satisficing concerns the fact that cognitive processes are not designed to seek optimal solutions, which would put too much load on attention. People tend to prefer to select biased (heuristic) but less demanding processes rather than analytical processes that are more efficient but whose cost in terms of attention is disproportionate to the gain. Thus, a biased mechanism may be preferred to all possible unbiased options. The relevance principle states that mental models generated in response to a problem-solving task are based intuitively on heuristic processes, because their role is to optimize their effectiveness in a given context and not to seek the most coherent model (Evans, 2007).

These three principles are the source of the two "fundamental biases" that cause individuals' errors of reasoning and apparent irrationality. The first is "heuristic bias", whereby people selectively focus on the most relevant aspects of a problem; the second is "analytical bias", whereby individuals maintain the generated mental model due to inadequate assessment or consideration of the alternatives (Evans, 2007). Heuristic bias arises from the relevance principle, while the analytical bias stems from the singularity and satisficing principles.

Cognitive biases can be defined as mental models that cause individuals to make systematic errors in logical or rational reasoning in certain situations.

Tversky and Kahneman (1983) created a scenario to illustrate these biases and the conflicting relationships that may exist between the two systems. The goal was to study probabilistic reasoning through understanding the conjunction rule, which states that the probability of an event A occurring alone is greater than or equal to the probability of event A occurring at the same time as event B [$P(A) \geq P$ (A and B)]. The scenario was the following:

Linda is 31 years old, single, straightforward and very bright. She has a master's degree in philosophy. As a student, she was very concerned about issues of discrimination and social justice and participated in anti-nuclear demonstrations. In your opinion, is Linda more likely to:

1. *Be a teacher in a primary school*
2. *Work in a bookstore and take yoga classes*
3. *Be active in the feminist movement*
4. *Be a psychiatric social worker*
5. *Be a member of the League of Women Voters.*
6. *Be a bank teller*
7. *Be an insurance salesperson.*
8. *Be a bank teller and active in the feminist movement.*

89% of individuals select proposition 8, which is in fact a conjunction of propositions 3 and 6 (and which is less probable than the proposition 6). Tversky & Kahneman (1983) explained that individuals do not use logical and probabilistic reasoning (the rule of the conjunction of probabilities) but a "representativeness heuristic" based on the descriptive elements of Linda's personality. They postulated that the brain automatically generates a "representativeness heuristic" due to the relevance principle. In the scenario, Linda's attributes activate the feminist stereotype. Although proposition 8 suggests that Linda is a bank teller, there is nothing in the scenario that clearly indicates this. The heuristic bias focuses strongly on certain personality characteristics, producing a dominant mental model whose serial functioning (singularity) prevents the analytical system from producing another more appropriate but demanding model.

Many dual-process models of cognition have been developed, using different terminologies and functional descriptions. Some have highlighted the importance of attention and the degree of control and awareness that individuals can have over their reasoning and decision-making (Posner and Snyder, 1975). Schneider & Shiffrin (1977) referred to two types of mechanism, "automatic" and "controlled". Different terminologies have been developed by specialists in the psychology of reasoning; for example, Camererry & al. (2004), Stananovitch & West (2000) and Kahneman (2011) refer to system 1 vs. system 2, Epstein et al. (1996) to experiential vs. logical system, Sloman (1996) to associationist vs. rule-based mechanisms, Dijksterhuis & van Holden (2006) to unconscious vs. conscious thoughts, and Greene (2013) to consequentialist vs. deontological ethics. These dualities are generally in line with Evans' views and affirm the existence of two main types of process in human cognitive functioning.

Duality is also mentioned in other fields. For example, in memory, Schacter (1986) distinguished between implicit and explicit memory; and in intelligence, Cattell (1971) made a distinction between fluid and crystallized intelligence; Gawronski & Bodenhausen (2006) distinguished between associative and propositional processes; Wilson, Lindsey, & Schooler (2000) contrasted explicit and implicit attitudes. In another domain, Greenberg & Arndt (2012) developed terror management theory, in which they describe a survival instinct that counters awareness of death. No research has yet found evidence of any structural convergence between these different fields, but this cannot be ruled out.

It seems therefore that researchers are drawn to the idea of developing dual-process models of psychological functioning. Is there some sort of magic in the number "2" that could "bias" some people's judgment?

Reason is the Slave of the Passions. – David Hume

The heuristic system comes into play first. It is automatically triggered by contextual inputs and internal representations, rather like an innate releasing mechanism (IRM), to generate a decision or judgment. The analytical system is only marginally involved at this stage, probably to approve the default response suggested by heuristically generated mental models (Evans, 2007). The analytical system would therefore work continuously to analyze all judgments and decisions of the heuristic system (Kahneman & Frederick, 2002).

Heuristic processes do not constitute a singular system but form a set of systems, described by Stanovich (2004) with the acronym TASS (The Autonomous Set of Systems). He postulates that they are autonomous for three reasons: they are automatic, they are not under the control of the analytical system, and they are likely to conflict with the analytical system that operates in parallel. He describes the analytical system using the image of a homunculus in a virtual machine. It is only this system that is sensitive to linguistic inputs, internal or external, that serve as a basis for hypothetical-deductive thinking and it is closely linked to the theory of mind. It would therefore be a source of meta-representations and would act in a conscious way. However, it is difficult to explain why the analytical system, if it has a superior control action, is so often invalidated by the heuristic system. It appears in some way to be a "slave". Experimental results clearly indicate that the heuristic system dominates the analytic system.

Houdé's proposition (2000, 2003) of a third autonomous system (triple process model) appears to respond to criticisms of Stanovich's model. Neurologically, this system would be situated in the prefrontal cortex and would therefore be a control system mediating between the other two systems on a case-by-case basis. It would control the inhibition processes enabling individuals to reason without cognitive bias by neutralizing the automatic thoughts or beliefs of the heuristic system when logic needs to be applied. This executive process would be a system of "cognitive resistance" to the expression of reasoning biases. This notion has had significant influence on research on the cognitive development of children, in areas such as number conservation (Borst & al., 2013), classification (Borst & al., 2013), reasoning (Cassotti & Moutier, 2010), decision-making (Aïté & al., 2018), and theories of mind (Aïté & al., 2016). Indeed, the heuristic/analytical distinction is comparable to Piaget's distinction between preoperational thinking, based on beliefs and heuristics (3-6/7 years), and operational thinking, based on logic (from 7 years). Houdé (2000) explains this development as the process of "cognitive resistance". At the preoperational level, our brain's ability to inhibit automatisms and therefore to resist the effect of beliefs (heuristics) on reasoning is insufficient to understand the world analytically. The two systems would therefore compete throughout life, with a strong predominance of the heuristic system in young children due to their limited inhibition processes. Both systems would therefore be "available" from birth.

But then why, despite our increasing inhibition capacities with age, do cognitive biases not tend to decrease? Furthermore, faced with some problems (e.g., related to sunk costs), research suggests that cognitive biases increase with age (Arkes & Ayton, 1999; Klaczynski & Cottrell, 2004; Morsanyi & Handley, 2008). Houdé's model assumes that the three systems (analytical, heuristic and inhibition) develop along different pathways, which would explain why some biases emerge in adolescence and even adulthood, while others disappear at a very early age in young children. Some heuristics become more prominent during development, which would explain why young children are less prone to certain biases than adolescents (Reyna, Wilhelms, McCormick & Weldon, 2015). The most recent version of this tripartite model (Houdé, 2014) assumes the existence of a conflict detection process that would or would not trigger the inhibition process. Detecting the conflict between the heuristic response and the analytical response, as well as questioning the responses produced, may be necessary for a change in strategy (from biased heuristic response to correct analytical response) (DeNeys, 2012). However, it remains to be explained why the prevalence of heuristics varies in different tasks.

The neurological argument put forward by Houdé is in line with the localization of brain functions observed in the 19th century by neuropathologists, notably Broca and Wernicke. They identified the language areas of the brain that bear their names. To validate a behavioral model stipulating the existence of a system 1 and a system 2, it is thus reasonable to assume that they are underpinned by different neural substrates or by different brain areas. Prefrontal cortex lesions cause deficits in decision-making and problem-solving in new situations requiring planning and anticipation. System 2 with its controlled processes would therefore be linked to activation of the orbital and prefrontal parts of the brain (Goel & Graflman, 1995, 2000 ; Lieberman, Gaunt, Gilbert & Trope, 2002). The prefrontal cortex is the site of executive functions (Shallice & Burgess, 1998) that integrate information and organize it in algorithmic forms. By contrast, automatic activities (intuitive, heuristic) would be linked to the activation of occipital, parietal and temporal areas, together with some central nuclei responsible for emotions (Camerer, Loewenstien & Prelec, 2005). These facts, based on numerous observations and experiments, are indisputable, but their interpretation in terms of behavior is open to debate. System 3 has functional characteristics related to executive functions and therefore to the prefrontal cortex. In this case, which brain areas underlie the processes of system 2, which should be found in other parts of the brain? In addition, linguistic activity requires the activation of many brain areas, particularly Broca's and Wernicke's regions. This does not mean that there are two language systems. While the disorders

caused by their injury are different, they are considered to function in a coordinated manner, without one biasing the activities of the other as significantly as system 1 does with system 2. Finally, activities that do not involve logical thinking and hypothetical deductive reasoning also require planning and forecasting (Damasio, 1994). Biased reasoning does not necessarily mean that there is no planning or forecasting.

The introduction of this third system leads to a representation of human cognitive functioning that raises another difficulty in the framework of evolutionary psychology (Cosmides, 1989 ; Cosmides & Tooby, 2003, Buss, 2011). Indeed, a dominant (heuristic) system, extensively used in daily life, and mostly adaptively, would occasionally be subject to inhibition processes that would allow the expression of an analytical system that is only marginally used in daily life. Examples given to justify the existence of a third system include academic tasks such as learning to solve arithmetic problems (Lubin & al., 2010). As pointed out by Stanovich (2004), heuristic processes sometimes lead to inadequate or inaccurate answers, particularly in the modern-day environment, which creates the need for analytical processes to override them. This is particularly the case in educational settings, from school to university, where the analytical system is extensively brought into play. However, the human cognitive system obviously developed before schools were created, so this clearly did not affect our ancestors. In other words, how could the analytical system and hence the third system evolve if the ecological context was not able to select the behaviors they are supposed to produce?

Nothing in biology makes sense except in the light of evolution. – Theodius Dobjansky

Dual-process models were developed to explain why most individuals fail to reason rationally. Most psychologists assume the existence of cognitive constraints and biases that undermine reasoning. We could be rational, but only under optimal conditions. These constraints are attentional and mnemonic and make it costly to implement hypothetical deductive mechanisms. Individuals prefer to rely on automatic and intuitive mechanisms, heuristics that have the advantage of being fast, inexpensive and generally adaptive. But the researchers could have asked a different question: "What is the purpose of reasoning in an ecological situation?" Indeed, if the heuristic system provides adequate adaptation in a very large number of ecological situations, then why has evolution selected an analytical system whose ecological utility may seem rather marginal? This enables the dual-process models to be examined in the light of Darwin's theory of evolution and its key concept of natural selection.

First, there is a consensus that the heuristic system emerged before the analytical system during hominization (Buss, 2011; Evans & Over, 1996). In the context of evolutionary theory, this time lag leads to the hypothesis that two selective pressures shaped the structure of human cognition at two different periods. Two pressures led homo sapiens to become rational. The heuristic system may have emerged earlier, perhaps in homo erectus, while the analytical system would be a specific characteristic of homo sapiens. The challenge is therefore to understand why evolution introduced a new (analytical) system rather than developing the heuristic system. Evolution occurs through a process of adjustments and approximation of the existing and not by ex-nihilo creation. It is economical and does not choose the most expensive options.

Natural selection is opportunistic and selects only the options that provide an adaptive advantage to organisms that increase the ability to transmit their genome by having more children (Mayr, 1991). Moreover, the cognitive processes that can be categorized as adaptations, in other words, resulting from natural selection, must be universal because they are innate. Heuristic processes are most effective in familiar situations, whereas analytical processes, although more expensive, are more useful in new situations. It is therefore surprising that a less costly solution has not evolved through natural selection, enabling heuristic processes to respond effectively to new situations.

According to the theory of evolution, the first step to understand the emergence of a new cognitive system is to answer the following questions: "What is the purpose of this new cognitive system for an organism in its natural environment?" and "How does it provide better adaptation?" In other words, what is the purpose of reasoning in an individual's universe and why is it biased?

Cognitive biases are universal, regardless of age, education and culture. The proponents of evolutionary psychology (Cosmides & Tooby, 1992) consider that the human brain and cognitive structure prevents individuals from reasoning according to the rules of formal logic. Our irrationality would therefore be part of our genetic heritage. While many researchers see cognitive biases as errors of reasoning, this was not the case for our prehistoric ancestors who had to make rapid decisions. They did not have the time to construct logically valid reasons because they had to adapt to their environment. Cognitive biases are therefore a biological legacy that has, in Darwinian terms, an important adaptive value. It would thus be absurd to imagine that we could rid ourselves of them in our daily activities. By the same token, we understand that our intuitions and our convictions generally prevail over mathematical calculation and logic in our daily lives.

Man is a social animal. – Aristotle

The massive development of our cognitive abilities compared to those of our ancestors has not been accompanied by the disappearance of cognitive biases. These seem to be inherent in reasoning and can be observed in all cultures. In the context of evolutionary theory, we must therefore recognize the universal nature of cognitive biases and accept the idea that they have a real adaptive value. The brain is thus not a symbol-processing machine designed to represent the world objectively and rationally. The human world is above all social and symbolic rather than material. Intelligence had first to provide an adaptive advantage for survival in an unpredictable environment before serving in an environment dominated by intra-specific social interactions. Many evolutionary psychologists emphasize the importance of the specific social environment that was at the root of the selection pressures that have shaped our cognitive system, thereby throwing into doubt the existence of two cognitive systems (Byrne & Whiten, 1988; Whiten & Byrne, 1997). The tasks used by psychologists in the field of reasoning are always constructed to validate their model. They are conceptual and often unrelated to social life. The reasoning sought is not motivated by the needs of the individual but by the purposes of the researcher. An alternative and more ecological model is argumentative theory, which assigns to reasoning the main function of producing and evaluating arguments to convince others or ourselves. Reasoning would therefore not serve to improve our knowledge and make rational decisions, but to convince others in social situations, and to identify those who seek to mislead us. The primary function of reasoning would thus be "argumentative" (Mercier & Sperber, 2011, 2017) and would be the product of social selection, as postulated in the ecological dominance/social competition model (Flinn & al., 2005). The argumentative theory therefore suggests the existence of a single cognitive system, assuming that reasoning is intrinsically biased by beliefs and automatisms of thought, regardless of age, educational level and culture. In social situations, rather than seeking rational coherence, individuals reason in order to convince others and position themselves socially.

The ability to argue would have been selected by evolution because it provided a more adaptive approach to those with the most resources. In other words, the argument would have a seductive power that would allow those who exercise it best to have more descendants (Bressler, 2006).

But why do the processes (heuristic and analytical) used in the same tasks function so differently? In other words, why can reasoning be so rational and unbiased in some cases? Argumentative theory gives key importance to the nature of social relationships between humans, which leads to the hypothesis that the group must influence the reasoning of individuals by inducing an increase in hypothetical-deductive reasoning,

which is therefore free of any cognitive bias. This is what most experimental results seem to show (Mercier & Sperber, 2011). For example, in Wason's selection task, which involves the analytical system, performance increases very significantly when the task is carried out in a group (Moshman & Geil, 1998; Maciejovsky & Budescu, 2007). The group situation leads to debate, disagreements and polemics that make it possible to choose between the right and the wrong arguments. The correct and rational answer in most cases tends to be imposed on most members of the group. Rationality therefore seems to emerge from the argumentative dynamics of the group by activating our ability to identify biases and beliefs in the arguments of others. The group is a social environment that can be described as metacognitive, which encourages us to function at an analytical level. Wason's selection task, when carried out individually, has an abstract and asocial character that favors reasoning marked by cognitive bias. Moreover, in a group, individuals have to defend and justify their answer, and therefore look for a solution that they can justify in the most convincing way; sometimes (often, for some people) the logical argument is the most convincing. Argumentative theory only makes predictions about the functioning of reasoning, predicting that if reasoning influences a decision, it will do so in the direction of the one that is most justifiable.

The importance of social interactions has also been mentioned and demonstrated in the context of operational development (Piaget, 1977). According to Piaget, the child moves from a preoperational stage (intuitive thinking) to an operational stage (logical thinking) around the age of 6-7 years. Piaget's (1977) theory of equilibration sees socio-cognitive conflict as one of the main factors of cognitive development. Socio-cognitive conflict occurs when several individuals (children, adolescents or adults) perform a task together, making them aware of the point of view of others (perspective taking) and sometimes making them reconsider their own view. It appears that individuals who change their minds generally do so by adopting a view that is easier to justify because it is more logically coherent. When two children at different stages of cognitive development work together, the child who does not have the ability to complete conservation tasks will generally accept the argument of one who has this ability because it is more coherent and therefore easier to justify (Doise & Mugny, 1981, 1997). More precisely, socio-cognitive conflict has a positive effect on learning if it is epistemic in nature, that is to say, when the collective arguments focus on the problem and the knowledge of the people involved, but it has a negative effect if it is relational, in other words, when the weight of the arguments is linked to status and social domination (Butera & Buchs, 2005; Darnon & al., 2006; Darnon & al., 2007; Johnson & Johnson, 2009).

Rational reasoning, according to argumentative theory, is not dominated or biased by heuristic processes. In accordance with the principles of evolutionary theory, argumentation tends to become rational when ecological conditions enable them to be more adaptive. This is clearly the case in institutional settings such as universities or schools where there is strong pressure to use analytical thinking, but in everyday social situations, heuristic thinking frequently becomes prominent again. Logical reasoning would thus be the optimal extension of heuristic reasoning.

Morality and language are singular but universal sciences. – Blaise Pascal

An individual's moral standards are expressed through judgments and reasoning. It can therefore be expected that the observations about dual models and argumentative theory will also apply to this area.

The particularity of moral situations is that they reflect a conflict between individual and collective interests. Their dilemmatic aspect forms the basis of the moral development model of Kohlberg & al. (1983). This model has had, and continues to have, a profound influence in moral psychology. It is both an extension and a systematization of Piaget's constructivist theory (1965, 1975). Piaget identified two fundamental periods in the child's moral development. Up to the age of 7 years, the child's morality is heteronomous; judgments concern the seriousness of the acts that are committed and not the intentions of the actors, and notions of right and wrong are linked only to the fear of punishment and therefore to the adult's authority. From the age of 7 years, the child enters the stage of autonomous morality. The child then considers the intentions of others and develops an increasingly refined understanding of the need for rules and regulations in social life. Kohlberg extended Piaget's model, with three stages, pre-conventional (heteronymic morality), conventional (autonomous morality) and post-conventional (morality based on universal ethical principles). The central point of these two theories is that moral development is intimately linked to cognitive development and thus to the development of thinking skills. According to Piaget, judgment at the stage of heteronomous morality is biased by cognitive egocentrism that is inherent to the child's cognitive functioning. By contrast, at the stage of autonomous morality, the child is capable of perspective taking and therefore to reason about moral situations, which corresponds to the stage of concrete operational thinking.

According to this view, reasoning skills therefore depend on the individual's stage of moral development. However, empirical evidence raises questions about this model. Many people who have reached the formal operational stage do not show the

moral behavior that corresponds to the post-conventional stage. Moreover, the moral behavior of individuals is affected by their emotional state and the specific situation. Thus, judgments in a situation involving people close to us (e.g. our children) are often typical of heteronomous morality and the pre-conventional stage. By contrast, in situations involving strangers, our judgments are generally based on autonomous morality and correspond to the conventional or post-conventional stage.

Haidt (2001, 2003) proposed a non-rationalist model in which moral judgment is not the product of conscious reasoning. The experimental situations used by Piaget and Kohlberg consisted of asking participants to make a judgment about a scenario or moral dilemma and then examining the sequence of verbalized justifications to determine their coherence and identify significant elements. They assumed that the judgment would be the outcome of deductive reasoning. Haidt (2001, 2003), on the other hand, proposed an intuitive model of moral judgment, which would be the product of unconscious and automatic cognitive processes within the heuristic system. The justifications would be part of an a posteriori rationalization process that the individual would consciously verbalize.

Anderson (2014) developed a model with similarities to Haidt's. It is a theory of information integration that aims to explain how multiple variables are integrated into a unitary moral response. One of Anderson's main criticisms of Piaget & Kohlberg's models concerns methodology; asking individuals to verbalize their justifications assumes erroneously that the individual reasoned in a hypothetical-deductive way, thereby in some way masking the reality of the processes, which are essentially unconscious. Consequently, he proposed a new experimental paradigm, in which participants had to judge a series of scenarios non-verbally by putting a cross on a scale. For example, participants are presented with a scenario involving an aggressor and a victim and are asked to indicate how severely the aggressor should be punished, on a scale of 0 to 10. By manipulating certain variables (e.g. seriousness of the consequences for the victim, intention of the aggressor, aggravating or extenuating circumstances, gender and age of the people involved), it is possible to determine what Anderson called the moral algebra (the way information is integrated) underlying moral judgments. The integration processes are essentially unconscious. Findings show that children consider the intentions of others earlier than suggested by Piaget & Kohlberg and that the moral developmental model is artificial. For Anderson, as for Haidt, moral judgment is essentially intuitive.

Furthermore, Haidt (2003) suggests that our moral intuitions are innate and therefore universal. Moral judgments would therefore have a biological basis and would also be the product of natural selection. He found evidence for five sets of innate intuitions:

1. those relating to the suffering of others (e.g. altruism, solicitude)
2. those relating to fairness and reciprocity (e.g. equal treatment)
3. those relating to membership of a social group (e.g. loyalty)
4. those relating to respect for authority (compliance with the group's principles)
5. those relating to purity and sanctity (religiosity)

According to Haidt (2003), we are born with these five sets of intuitions, which develop differentially in specific situations and cultures, some increasing in importance, others diminishing. As with Anderson's moral algebra, the patterns of these sets of intuitions form part of the individual's personality. Haidt suggests that there is a critical period in childhood, and that an intuition that has failed to develop by then never will. Here, Haidt borrows from psycholinguistics the "theory of learning by forgetting".

Taking a similar approach to Anderson & Haidt, Hauser (2006) & Mikhail (2011) developed a model based on the idea of an innate universal moral grammar, in line with Rawls' linguistic analogy (1971). Their reference is Noam Chomsky (1967), who postulated that linguistic competence is based on an innate universal grammar. This emerges after a "critical period" of child development, with the mastery of a specific language. According to Chomsky, we cannot teach a human being to speak any more than we can teach a bird how to fly.

Moral grammar would thus be made up of universal moral principles, and also of "functions" enabling children to integrate the value system of their environment and internalize the specific moral principles of their cultural universe (Mikhail & al, 1998; Mikhail, 2011). We therefore have a unique moral competence, expressed through moral performance linked to our culture and our upbringing.

Hauser & al. (2007) provided experimental evidence to support their thesis using the trolley dilemma (Foot, 1967; Thomson, 1976). This dilemma is presented in two versions that trigger different answers.

In the first version, the moral dilemma is presented as follows: *A runaway trolley is heading down the tracks. Five workers are carrying out repairs on the track. On another track on which the trolley can be redirected, there is one worker. An employee of the trolley sees the situation and is standing next to a switch that can divert the trolley. If he pulls the switch, he will avoid the death of the five workers, and if he does not, he will avoid the death of a single worker. Should he divert the trolley to the other track?*

In the second version, the dilemma is presented as follows: *A runaway trolley is heading down the track. Five workers are carrying out repairs on the track. John is crossing a bridge over the track and realizes that he can stop the trolley by throwing*

something big on the track. A pedestrian carrying a bulky bag is walking next to him. If he pushes the man onto the track, the trolley will stop, saving the lives of the five workers but killing the pedestrian. Should he push the pedestrian off the bridge?

Presented with the first version, most people argue that it is morally acceptable to divert the trolley. By contrast, regarding the second version, most people argue that it is morally unacceptable to push the pedestrian onto the track. In both cases, moral reasoning is universal, and is independent of level of education, religion and culture, providing evidence for the existence of a universal moral grammar (Hauser & al., 2007).

More specifically Hauser & al. (2007) identified three categories of justification, irrespective of the quality of the arguments or reasoning. The first is called "sufficient"; it concerns a correct and factual identification of the difference between the two scenarios, forming the basis of the individual's moral judgments. For example, operating the switch is impersonal, while deliberately pushing a man off the bridge is personal and emotionally charged. The second category is called "insufficient". Here, the justifications are not based on factual differences between the two scenarios; either individuals provide no justification for their judgment (e.g. "it seems reasonable"), or they just say that death or homicide is unavoidable in one case but not in the other, or they use utilitarian reasoning in one case (maximizing the greatest good: "we save five people and sacrifice one by pulling the switch") and ethical reasoning by referring to moral principles in the other case (e.g. "deciding who lives and who dies is to think of oneself as God"). The third category involves arguments that introduce additional elements that are not included in the scenario (e.g. "a man's body cannot stop a train"). In most cases, it seems that people are unable to explain the basis for their argument. Moral judgments would therefore essentially be the product of an unconscious and intuitive activity.

How then can we explain why it is considered moral to sacrifice one life in the first dilemma but not in the second? The dual-process models and argumentative theory lead to two different interpretations.

With the dual-process model, we can refer to a cognitive bias whereby reasoning is influenced by the way the problem is framed. Tversky & Kahneman (1981) illustrated this by presenting participants with two versions of a problem (as in the trolley dilemma):

Doctors are given statistics about two types of treatment for lung cancer: surgery and radiation therapy. Surgery leads to a higher 5-year survival rate but is much riskier than radiotherapy in the short term. Half the participants are told that "the survival rate one month after surgery is 90%", while the other half are told that "the mortality rate one month after surgery is 10%".

Participants were asked to choose the best treatment. When the problem was framed positively giving the survival rate, 84% chose surgery, whereas when it referred to the death rate, 50% chose radiotherapy. The two situations are strictly identical, a 90% survival rate being the same as a 10% death rate, similar to the trolley dilemma, in which both versions involve one death to save five lives. According to dual-process models, heuristic processes are activated first and automatically produce different beliefs or heuristics in the two situations, biasing analytical processes that would otherwise lead to a single conclusion in both versions of Tversky & Kahneman's problem and of the trolley dilemma.

According to Evans (1989), three elements determine whether the analytical system will override the heuristic system. First, the way the problem is presented; the more it emphasizes the formal aspect, the more the reasoning will be rational. The second element concerns the general intelligence of the participants; the higher it is, the greater the probability of activating the analytical system. The third element is the time allowed to solve the problem; giving more time would reduce the influence of cognitive biases.

The participants presented with the statistical problem were doctors, therefore educated and intelligent people, who would clearly have understood that a 90% survival rate and a 10% death rate were the same. In addition, there was no time limit to solve the problem. For the trolley dilemma, the solution is unrelated to the level of education and is independent of the cultural context, and there was no time limit. So, what is the intuitive automatic thinking that the analytical system or System 3 fails to inhibit in the two problems? Unlike Wason's selection task, there is no correct answer to Tversky & Kahneman's statistical problem or the trolley dilemma. Wason's task is based on logical rules of implication and is abstract and not ecological. The reasoning produced is therefore not driven by the needs or moral motivations of the individual. By contrast, the trolley dilemma and the statistical problem have an ecological dimension (choice of medical treatment, choice of a moral act). Reasoning is therefore driven by the individual's value system. The two situations of both the trolley dilemma and the statistical problem are treated independently without seeking coherence. Argumentative theory suggests that, in this situation, individuals choose the solution that is the easiest to justify, based on essentially unconscious moral principles. Thus, it is easier to justify the choice of treatment by the survival rate than by the death rate, and it is easier to justify the choice to divert the trolley by pulling a switch than to stop it by pushing a person onto the track. The ecological function of reasoning is to defend an opinion; the first stage is therefore intuitive, leading automatically to a conclusion that the individual

then tries to defend rationally. This can be shown to be flawed in a debate, but if the intuition (heuristics) is sufficiently powerful, it will resist any counter suggestions. It is like an impenetrable module (Fodor, 1983). This can be seen in certain fields such as politics, where people are often convinced that they are right and the others wrong. Debates frequently only reinforce people's intuitions. This accounts for many choices made by countries throughout history; politics has sometimes led people to make disastrous choices. The course of history is thus chaotic and irrational. Currently, the phenomenon of fake news on the Internet and the fact that many people are taken in by it also testifies to the power of heuristics and its impenetrability to logical demonstrations and arguments.

The people with the most mind is the most unreasonable when their passions are at stake, because then their whole minds are focused on finding arguments in favor of their madness. – Maria Edgeworth

Since Aristotle, it has been common to contrast reasoning or demonstration with argumentation (Walton, 2013). The former is based on impersonal and certain universally recognized premises, while the latter is based on uncertain and generally personal premises. It would follow that argument is just a spurious demonstration. Everything therefore depends on the quality of the premises. However, self-evident premises, or axioms in mathematics, are typically accepted without having been demonstrated. In the history of mathematics, there are many examples of arbitrarily defined axioms. For example, some of Euclid's axioms, when challenged, led to the development of new non-Euclidean geometry. Axioms therefore do not seem to be any more certain than our opinions and intuitions.

The difference between demonstration and argumentation can thus be said to lie in the fact that the former is based on the use of the rules of formal logic and the latter on the use of metaphors, analogies and generalizations. But here again, analysis of political discourse, which is a type of argumentation, shows that it contains many logical demonstrations, which do not necessarily persuade all the people who are targeted.

Is the difference then in the purpose of the speaker? To demonstrate a point and convince others of its validity, the speaker does not show any personal involvement, whereas when arguing, the speaker is personally and emotionally involved, and may sometimes use fallacious arguments in order to convince the listeners. This suggests that there is a continuum between demonstration and argumentation, linked to the nature of the task (abstract vs. concrete); the more a logical task is personally motivated, the more successful it would be.

To develop this idea, let's return to Wason's selection task described at the beginning of the chapter. In its traditional and abstract version, only 10% of people succeed, and even less when they are asked to justify their answer. However, there is a concrete and deontological version that is similar in its logical structure to Wason's task (Johnson-Laird, 1972; Griggs & Cox, 1982):

Four people are in a bar: the first is having an alcoholic drink, the second is under 18 years old, the third is over 18 years old and the fourth is drinking a soft drink. Who should you question to ensure that the following rule is true: if someone drinks alcohol here, he or she is over 18 years of age.

More than 50% of people are successful in the task, and in most cases their justifications largely respect the rules of logic. They choose to question the first person because he is drinking alcohol and the second one about what he is drinking. But few people choose to ask the third person about what he is drinking or the fourth who is not drinking alcohol. This version creates a mental model (Johnson-Laird, 1972) that is easier to justify than the abstract version.

This selection task nevertheless has a problem with the material conditional (as defined in classical logic), illustrating the impossibility of finding an absolute criterion of differentiation between demonstration and argumentation. Logical implication has been a problem for logicians since antiquity and appears in the justifications given by non-scientists in Wason's task. Whitehead & Russell (1910/1913) in their Principia Mathematica, following Frege (1869), interpreted "if p then q" as "no p without q". This interpretation led to the production of a surprising truth table of logical implication: If p and q are true, then the implication is true, and if p is true and q is false then the implication is false. But if p is false and q is true then the implication is true, and, the most surprising consequence, if p and q are false then the implication is true. Logically, this leads to the conclusion that the conditional statement "if the Pope is a woman then the earth is round" is true, and even that the conditional statement "if the Pope is a woman then the earth is flat" is also true! C.I. Lewis (1918-1960) was dissatisfied with the truth table of logical implication and tried with relative success to develop a model of strict implication, more respectful of everyday language, which is always expressed within a contextual field. He then tried to develop a pragmatic logic, closer to everyday language, challenging the formal logic of *Principia Mathematica*. He raised the question of the link between the logic in everyday language and argumentative activities. Like other people, logicians thus experience the doubts raised by their model and feel the need to justify their arguments.

The Swiss logician Jean Blaise Grize (1982) defended the idea that individuals use the discourse of mental models in both demonstration and argumentation. However, for argumentation, these models are logically imperfect and Grize called them "schematizations", whose aim is to find relevance in relation to the context. They are extensively used in the practical activities of everyday life. By contrast, in a demonstration, mental models reflect a search for logical coherence in relation to the content. This is found particularly in scientific activities. Schematizations and mental models are not distinct, but lie on a continuum.

In the beginning was the word, and the word was in God and the word was God. – Prologue to the Gospel according to Saint John

In conclusion, we will discuss the links between language, reasoning, argumentation and the theory of evolution. We rarely reason in our daily lives and we use our language to communicate our thoughts about ourselves and others, our feelings, our opinions about the world or our projects, or to defend our ideas on different subjects such as politics or religion. Language is therefore used primarily to argue in the ecosystems in which we live, which are above all symbolic and social. Argumentation is therefore not what we do with language, but it is engraved in the language. Evolutionary psychology, within the framework of Darwinian theory, raises the following question about the emergence of language during hominization: "What selective pressure led our ancestors to have such a need to argue with their peers?"

From an evolutionary point of view, a valid theory of the emergence of language must include five principles. First, it must define the ecological universe in which it emerged and its pressures. Secondly, since language is a universal competence, it must explain how it served the immediate and habitual needs of our ancestors. Third, it must be able to explain the singularity of the phenomenon: Why has no other animal species developed an articulated and syntactic language? Fourth, language conveys information, and the speaker can therefore mislead others with false information. This raises the question of the credibility of the information that is conveyed (Zahavi, 1977; Knight & Botha, 2009). How could language appear if it can be socially used to fool others? What would its adaptive value be? Finally, when a chimpanzee discovers a food supply, it behaves selfishly to avoid having to share it. How did our ancestors break down the stronghold of selfishness to allow the emergence of language, which is above all an interactive activity?

Derek Bickerton (2009) proposed a theory of the evolution of language based on these five principles, and which we believe is compatible with Mercier and Sperber's argumentative theory (2011, 2017).

What was the ecological universe of our African ancestors? According to scientific field data, the first hominin (Australopithecus and homo habilis) were opportunistic omnivores. Their diet therefore contained meat. In addition to the small prey they hunted themselves, they were socially organized to steal parts of the prey of the large carnivores, which they had not hunted themselves. The climate change that occurred two million years ago in Africa caused an aridification that led the first hominins to leave the forests and occupy new niches such as savannahs. This led to a grassland-based lifestyle and therefore a change in the use of food resources (Aiello & Wheeler, 1995; Pickering & al., 2013)

In this new context, hominins developed group strategies requiring strong social cohesion and a more sophisticated communication system. Stealing prey from a large predator was far too dangerous to be done alone. We can therefore imagine that having identified a prey killed by a large predator, a homo habilis would fetch his peers to ensure safety in numbers (Bickerton, 2009). He therefore needed a communication system to tell his peers about a situation that they could not see, breaking down the stronghold of the here and now that characterized the pongidae's communication systems. There was therefore extremely strong selective pressure on our ancestors over a long period of time, creating strong social dependence, maintained by the new mode of communication, namely articulated language.

More specifically, Derek Bickerton (1990) proposed a two-stage model of language development among hominins. The first hominins would have developed a protolanguage consisting of words uttered in no strict order and therefore without syntax. According to Bickerton, it could have resembled the language that humans teach chimpanzees, the language of two-year-olds, or pidgin. These all share the common features of being composed only of concrete words and of having no syntax. In the second stage, probably only reached by homo sapiens, the articulated language took the form we know today.

The emergence of language thus created a new niche, a symbolic and social human ecosystem. A phenomenon of autocatalysis then occurred, making language a universal human competence. The complexification of language entered a circular process as the social structure also became more complex. Bickerton's theory respects the five principles mentioned above. Hominins had to adapt by developing a new communication system to a new ecological niche that differed from that of other apes. In addition, the need to provide information about new food resources replaced selfish intentions to mislead peers and withhold information about a food source. The rapid increase in interactions as a result of the development of syntax intensified social competition, making argumentation the main cognitive activity within human communities. Moreover, the appearance of moral intuitions in the genetic baggage takes on its full meaning in a community in which the interdependence of members is a matter of survival (Comides & al., 2018).

This autocatalysis also led to the emergence of a new form of evolution linked to the collapse of the stronghold of the here and now. It was no longer based on the Darwinian model of natural selection but on the Lamarckian model of cultural transmission. Thus, man transformed his universe by creating new niches for himself, from the savannah to the media and digital universe in which we currently live.

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Chapter 2
Cognitive Structure of Moral Reasoning, Development, and Evolution With Age and Pathology

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ABSTRACT

This chapter presents research on moral judgment from the beginning of the 20th century to the present day. First, the authors will present the contribution of Piaget and Kohlberg's work on moral development from childhood to adulthood as well as the work of Gilligan on moral orientation and the difference observed between men and women. Then, the authors will analyze underlying structures of moral judgment in the light of the Dual Process Theory with two systems: system 1: quick, deontological, emotional, intuitive, automatic, and system 2: slow, utilitarian, rational, controlled, involved in human reasoning. Finally, the model of Dual Process Theory will be confronted with data from moral judgment experiments, run on elderly adults with Alzheimer's disease, teenagers with Autism Spectrum Disorder, and children and teenagers with intellectual disability in order to understand how cognitive impairment affects the structures and components of moral judgment.

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INTRODUCTION

Social interactions with others play a crucial role in child development. Through social interactions, children begin to establish a sense of "self" and to learn what others expect from them. When playing with others, children learn appropriate social behaviors, such as sharing, cooperating, and respecting the property of others. Social interactions in the early years enhance not only cognitive development but also moral reasoning, perspective taking of others and prosocial behaviors. Children learn social rules and need to know what is allowed and forbidden in the group they belong to in order to fit in successfully.

In this chapter we will chronologically investigate the different aspects of moral judgment and moral reasoning through the following authors: Piaget, Kohlberg and Gilligan who are considered as the pioneers of moral reasoning research. We will first highlight their contributions in the understanding of moral reasoning. Then we will focus on the recent theory of dual system theory which we will use to explain the cognitive structures of moral judgment and their evolution with ageing and mental disorders.

PIONEER WORK ON MORAL REASONING

Piaget's Theory

In studying moral reasoning through "rule games" with children, Piaget (1932) distinguished three stages in children's awareness of rules related to their age: "pre-moral judgment" (up to 4-5 y/o, in which rules cannot be understood); "moral realism" (from 5 to 10 y/o, in which rules are seen as coming from a higher authority and cannot be changed); and a "moral subjectivism", (after 10 years old, in which rules are seen as mutually agreed by the players, and can be changed through mutual consent). Cognitive development leads to the decline of egocentrism and the growth of perspective taking of others. Consequently, the unilateral respect of the higher authority (usually an adult), evolves into an agreement in which equality between peers and an autonomous morality of reciprocity prevail. In a further study of moral reasoning, Piaget asked children to judge within the context of a story, the behaviour of a person according to his intent and the consequence of his action. Children had to give a verbal explanation of their judgment. Piaget's results showed that before 10 years old children judge on the basis of the consequence

rather than on the basis of intent because the consequence is objective and does not require perspective taking of others. On the contrary, less egocentric older children take the perspective of others into account and judge according to the subjective intent of the actor. However, Piaget's method has been criticised. Karniol (1978) for instance, has shown that children as young as five years old are able to judge on the basis of intent if intentional actions are explicitly contrasted with accidental actions with equal consequences. More recently, Cushman, Sheketoff, Wharton, & Carey (2013) have shown that between the ages of 4 – 8 years, moral judgments become increasingly intent-focused. However, their judgements differ between accidental harm with a negative consequence and attempted harm with a benign consequence. In the first situation children tend to punish the action while they do not in the second. Therefore, during childhood the decisive element in the moral judgment process shifts from consequence to intent. Piaget's theory has recently been reviewed, and it has been shown that children from 4 years old are able to take intent into account, and children from 4 to 8 years increasingly take intent into account (Cushman, et al., 2013).

Kohlberg's Theory

According to Kohlberg (1976, 1984) who developed Piaget's theoretical and empirical work, the development of moral reasoning can be classified in terms of three levels each containing two stages:

1. The "pre-conventional morality" level. At this level the morality of an action is judged by its direct outcome and external consequence. It is similar to Piaget's moral realism. Moral development is only concerned with the self in an egocentric way.
2. The "conventional morality" level. This level is similar to Piaget's "moral subjectivism". Individuals judge the morality of actions in a conventional way by comparing them with society's views and expectations. They obey rules and follow society's norms judging as right what conforms to social rules and as wrong what does not.
3. The "post-conventional morality" level at which people accept social rules because they accept the general moral principles underlying these rules. Their own ethical principles include life, liberty and justice as unalterable human rights. Therefore, social rules should not be obeyed when they do not respect human rights. Ultimately, moral reasoning is based on the principles of justice,

truth and right. As the person develops from childhood to adulthood, s/he passes through the different moral stages with ever more importance given to the underlying principles of moral reasoning. Whilst this theory presents an interesting understanding of moral reasoning processes, a substantial number of criticisms have been raised, most notably by Carol Gilligan.

Gilligan: Moral Reasoning and Gender

According to Gilligan (1982) the sequence of stages described by Kohlberg reflects only the development of male morality, as the participants in his studies were all males. Gilligan (1982) believes moral reasoning differs according to the gender of the participants. She suggests a "female psychology" differs from a "male psychology". In her study, she interviewed 29 women aged between 15 and 33 years old who were attending abortion and pregnancy counselling services. The real-life dilemma of these women was either to have a termination or to carry on with the pregnancy. Gilligan's results were not found to be congruent with the judgement universally applicable in to Kohlberg's final stages. She defined Kohlberg's male judgement process as "Justice Orientation" because it relies on the human principles of justice, truth and right. Her results show that women focus more on "responsibility" than on "justice". Women made rational, context-dependent judgements that were more concerned with the impact of their behaviour on people's feelings. Contrary to the "male characteristic" which put principles before people, the "female characteristic" will tend to put people before principle. Gilligan suggests an alternative feminine ethical handling of care and responsibility; a kind of "care orientation" as it is more representative of women's moral reasoning than a "justice orientation". In 1988, Carol Gilligan's further investigations on moral development studied the distinction between Justice and Care perspectives in the moral development of men and women. This study showed that both orientations (justice and care) were used by men and women, but care-focus dilemmas were mostly frequently used by women whilst justice-focus dilemmas were mostly used by men. According to Gilligan (1986), both moral orientations stem from different moral structures causing a gender-determined prevalence for one moral judgment orientation.

MORAL JUDGMENT

Other critics (Levine 1976) have expressed concern of the use of lengthy fictitious dilemmas and verbal explanations in the experimental work of the previously mentioned authors. According to Hommers and Lee (2010), and Hommers, Lewand, and Ehrmann (2012), Anderson's alternative methodology avoids these criticisms.

Anderson' Social Information Integration Theory

According to Anderson (1996, 2008, 2013, 2014) a judgement is a decision process based on the combination of data, which can be analyzed because each piece of information is given a specific value. Judgement activity follows specific rules. The knowledge of these rules paves the way to a better understanding of the reasoning mechanisms behind moral judgement. Within moral judgement research, the judgement of blame has been the most frequently studied topic, evaluating the consequences of a negative act and of the intent behind it. Indeed, in the judgement of blame, people judge an action by weighing different factors such as the consequence of the action and the actor's level of intent. The algebraic structure of a judgement depends on how people combine these two factors, and the rules of judgement they use, i.e. the importance they give to each of these factors. When two factors: "bad" intent and "adverse" consequence are combined with their two possible outcomes (with-without), one obtains four possibilities: with intent - with consequence, with intent- without consequence, without intention - with consequence and without intent - without consequence. According to Anderson, three kinds of algebraic structures can be observed (a) mono-factorial: only one factor is taken into account, (b) additive: the importance given to each factor is not modulated according to the other and (c) multiplicative: the importance given to one factor varies according to the other factor.

A common rule observed by Surber (1977) abides by the following function: Blame $= f(w$ intent $+ w'$ Consequence$/ w + w')$. Where w and w' are weights given by the person to the factors of intent and consequence. This rule is valid only if Intent > 0. While this function remains unchanged during the subject's life span, the weight given to each factor varies with age (Przygotzki & Mullet 1997). Children give more importance to the consequence factor and less importance to the intent factor than teenagers, young adults and elderly adults. Teenagers and adults give more importance to the intention and less to the consequence. While children develop an

additive algebraic structure, the algebraic structure of teenagers and adults is usually multiplicative. Anderson's function is congruent with the earlier research of Piaget and Kohlberg and develops their previous models of judgment using a moral algebra with the general rules of judgment observed at different ages of life. However, in addition to the ageing process, other factors can also affect moral judgement.

Factors Affecting Moral Judgement

Some studies have found that in moral judgement situations involving children, to whom praise or blame has to be assigned, the age of the actor does affect the judgement. For example, leniency arises when judging younger actors who deliberately misbehave (Salvano-Pardieu, Fontaine, Bouazzaoui & Florer, 2009). Analysing teachers' representation of sanctions using Anderson's method, Salvano-Pardieu et al, (2009) showed that the age of the child, his familial situation and his behaviour affect the teachers' degree of sanction. Two points were clearly observed: all teachers sanction a disciplinary problem more severely than a schoolwork problem and teachers in primary school are more lenient with their pupils than teachers in secondary school. In addition, unlike teachers in secondary school, primary school teachers took into account the familial situation of their pupils and punished less severely disruptive behaviour and the recidivism of a pupil when he was facing familial difficulties such as the divorce of his parents. In addition, Salvano-Pardieu et al., (2009) showed that age and experience of the teachers affected their judgement of sanction. Indeed, the oldest and most experienced teachers were also the most lenient with their pupils and the youngest teachers, who had less than five years of teaching experience, the most severe. This result, congruent with a previous finding (Pratt, Diessner, Pratt, Hunsberger, & Pancer, 1996) shows that although the moral stages may not evolve any further during adulthood, the weight given to the factors involved in the moral judgement continue to change with the ageing process. Finally, this result does not corroborate Gilligan's theory. No difference in the blame judgement of male and female teachers was observed.

While adults judge less severely younger actors who deliberately misbehave (Salvano-Pardieu, et al., 2009), the opposite is observed with children who have to assign blame to an aggressor (Fontaine, Salvano-Pardieu, Pulford & Crouzet, 2002). These authors studied the judgment of blame of physically abused and non-abused boys from 8 to 13 years old. These boys had to judge in different situations of social interaction the behaviour of an aggressor facing a victim. Different factors were analysed: the nature of the violence (verbal vs physical), the motive of the aggressor

(with vs without), the presence of the consequence (with vs without), the age of the aggressor (adult vs child) and the proximity between the aggressor and the victim (family vs stranger). The results show that when children have to assign blame, the age of the perpetrator is taken into account if a motive triggered his action. In this case, adults are judged more leniently than children. In addition, abused boys, unlike other children, judge more leniently the aggressor, even if he has no motive to be aggressive, when he is a family member of the victim. This effect, observed only with abused children suggests these children reproduce the moral schema of their parents and judge violent acts as less reprehensible especially when they come from a relative (Young, 2003). To conclude, when it comes to judging violent acts abused children present a similar moral algebra than typical children except when the violence comes from a relative in which case they are more lenient.

Whilst these studies highlight factors affecting moral judgement and its development with typical individuals, they do not inform us on the underlying cognitive structures: their role or their resistance to the ageing process and mental disorders.

The Structure of the Moral Judgement

How people combine intent and consequence is only one aspect of the structure of moral judgement. Judging an action based on social interaction implies understanding the actor's and the victim's thoughts and to be aware of the social rules in order to decide if this action is acceptable or not. The ability to judge whether a situation or an action is acceptable in a specific context and whether to blame the actor seems to be linked to deontic reasoning. In 'deontic' reasoning people understand and judge according to the principles ruling our social lives (Manktelow & Over, 1991). In this type of reasoning, the subject adopts a violation detection strategy (Cummins, 1996). He has to assess if a rule has been violated or not and if so detect which one has been violated. According to Cummins (1996), deontic reasoning is the most basic form of reasoning. People must be aware of social rules before they can apply violation detection and blame the actor. When the subject issues a judgement about the morality of an action and the blame to apportion to the actor, he must be able to use deontic reasoning to decide whether the action is tolerated in social life and whether the actor is blameworthy. In the judgement of blame the person apportioning blame has to determine: (1) whether the action was permitted by social rules; (2) whether it was deliberately perpetrated, and (3) whether the consequence of this action is serious. This cognitive ability emerges around 2-3 years old.

The second ability, "perspective taking" relying on Theory of Mind (ToM), can be quantified as the effectiveness with which we can reason about others' beliefs and intentions. The capacity to engage in perspective taking abilities comes usually later (around 4-5 years old) than deontic reasoning. One can appreciate which actions are allowed or forbidden and in what circumstances without awareness of the actor's motivation or intention. The ability to issue a judgement of blame is at first linked with deontic reasoning. If deontic reasoning alone was involved in the judgement of blame, blame would always be apportioned the same according to the consequence of the violated rule. On the contrary, in many circumstances apportioning blame is modulated by the intent of the actor, the seriousness of his/her action and the seriousness of the possible consequence. This suggests that the sanction is modulated according to the intentions of the actor therefore judging an action requires ToM (i.e. the ability to understand the thoughts, beliefs and mental states of others) and the perspective taking of others. Indeed, to define the most appropriate sanction, the person judging has to take the two following factors into account: the perpetrator's bad intention or his absence of bad intention and the seriousness of an adverse consequence, or possible adverse consequence. This suggests that those two cognitive abilities: deontic reasoning (linked with violation detection strategy) and perspective taking of others (linked with ToM), are involved in moral judgement. Different studies have analyzed moral judgment to better understand underlying mechanisms and cognitive processes involved in this judgment. The following studies explore the structure of moral judgment with different populations either with or without mental disorders and at different levels of development.

The Dual Process Theory (DPT)

In recent years, research on moral judgement has developed considerably. Most of this research reports multiple complex processes implicating neural networks within various areas of the brain (Young, Bechara, Tranel, Damasio & Hauser 2010; Young, Camprodon, Hauser, Pascual-Leone & Saxe 2010; Young, Cushman, Hauser & Saxe 2007). Processes, such as Theory of Mind (ToM) (Premack and Woodruff, 1978), executive control and abstract reasoning are involved in moral judgement. Most of this research is based on the characteristics of human reasoning and the work of Kahneman (2011). Indeed, many authors (Paxton & Greene, 2010; Gleichgerrcht & Young, 2013; Cushman, et al, 2013; Cushman, 2008) base their theory on a dual system: the dual process theory (DPT) to explain the properties of moral reasoning. DPT associated with the field of reasoning, decision making and judgment such

as moral judgment is characterized by the action of two systems with distinct cognitive processes. These two systems can be classified as Type 1 (T1): a fast system comprising of emotional, deontological, intuitive, and automatic processes and Type 2 (T2): a slow system with rational, utilitarian, and controlled processes. These processes play an important role in guiding everyday reasoning, judgment and decision making and in developing our social adaptation. Indeed, according to Greene (2014), on the one hand, moral judgments that can be characterized as deontological are preferentially supported by automatic and emotional processes and intuitions which rely on system 1. On the other hand, utilitarian judgments seem to be supported by conscious and controlled processes, associated with system 2.

It has been observed that these two aspects of moral reasoning could be congruent, in competition or in conflict. According to Cushman, Young & Greene, (2010), the dual system theory, opposing cognitive, rational and utilitarian judgements to emotional, intuitive and deontological judgements, is not sufficient and seems inadequate to explain the complexity of moral reasoning. Indeed, this duality between affective-emotional and cognitive-rational components is not pertinent, but rather these two components are integrated in moral judgement (Cushman & Greene, 2012; Cushman et al 2010). In their alternative model, Cushman et al. (2013) distinguish between two processes: one assigning a value directly to the action (for example "hitting someone is wrong") and one valuing the expected consequence of the action for the victim or potential victim ("hitting someone will cause him injury"). According to Fontaine et al. (2004) and Salvano-Pardieu (2016) the first process (the consideration of the action) depends on the knowledge of social rules, and deontic reasoning (Manktelow & Over, 1991; Manktelow 1999, 2012), and could be associated with system 1 i.e. quick, emotional and implicit, while the latter process (the consideration of the expected consequence for the victim or potential victim) depends on ToM and the consideration of the other's perspective and could be associated with system 2 i.e. slow, rational and controlled.

The ETIC Model (Emotion, Theory of Mind, Inhibitory Control)

Buon et al. (2016) developed a model of moral judgment based on three components: Emotion, Theory of mind and inhibitory Control. This model based on Cushman's (2008) dual system theory describes one system involved in the evaluation of the agent's action, and a further system involved in the evaluation of the agent's intention. As mentioned previously, these two evaluation systems can act in concert, in opposition or in competition (Cushman et al., 2013). For instance, in "intentional

harm", both systems act together: the action causes harm and the intention is to harm. The absence of conflict or competition between both systems ("action evaluation" and "intention evaluation") results in a straightforward moral judgement. In addition, the ToM's implication leads to the fact that there is a bad intention, therefore, a negative emotion is automatically generated due to the aversion of doing harm and to the emotional contagion in perceiving someone in distress.

According to the authors, this negative emotion would be the crucial input taken into consideration in the evaluation of the action.

In "accidental harm", both systems are conflicting, because the outputs of each system are opposed; the action results in harming, but the intention is not to harm. The action evaluation system leads to a negative output and the intentional evaluation system leads to a neutral output. The abilities of the ToM allow one to determine that there is no intention to harm. In this situation, inhibitory control is activated to inhibit the negative emotional reaction and the negative evaluation of the action associated with system 1. The activation of the inhibitory control results in the dominance of the ToM and allows a judgement based on the intentional evaluation system associated with system 2. This proposal suggests that inhibitory control modulates the dual system. Finally, in an "attempted harm" scenario, the two systems are in competition. Since the action causes no harm, the action evaluation system is not activated. In contrast, since the intention is to harm, the intention-based evaluation system is activated; in fact, only the intention-based evaluation system associated within system 2 is activated. With the "bad" action not being committed, the evaluation system of the action is not activated and only ToM's ability is involved. Because the emotional reaction cannot depend on the emotional contagion of the output of the action, the evaluation of the agent's intention will depend on one's ability to be empathetic, to take into consideration the other's perspective and to anticipate any harm that may have occurred to the victim.

These models bring an important contribution to the understanding of moral reasoning and enhance the role of intention and action in moral judgement. These two components of moral judgement that would be supported by a dual system ("evaluation of the action" vs "evaluation of the intention") can also be analyzed in terms of Anderson's Information Integration Theory (1981, 2013). For example, in moral judgement, people judge an action by measuring different factors such as the outcome of the action and the agent's intention. The moral algebra (how people combine the outcome of the action with the agent's intention) in a judgement of harmful actions, depends on the weight they give to each factor. When the factors, "negative agent's intention" and "bad outcome of the action" are combined with

their two levels (with and without), four situations are possible: intent-bad outcome (intentional harm); intent – no outcome (attempted harm); no intent-bad outcome (accidental harm); no intent-no outcome (no harm). These four situations have been investigated in experiments to analyze the moral algebra of children, adolescents and adults with and without mental illness. In addition, moral judgments were analyzed according to the dual system and the ETIC model.

RECENT RESEARCH ON MORAL JUDGMENT STRUCTURES.

In order to test the integrative model based on a dual system and a moral algebra and to analyze the role of its various components (ToM, Deontic reasoning, Emotion and Inhibitory Control) the authors aim to compare different populations with and without pathology to investigate whether these different moral reasoning components are affected or not by the pathology. This research will also allow further investigation of the role of system 1 and system 2 within moral reasoning.

The first experiment was designed to analyze the effect of the aging process on these components; the moral algebra of elderly people with and without Alzheimer's disease (AD) was compared.

If the moral reasoning structures are affected at the early stages of AD then understanding how they alter will give a better insight into their fundamental mechanism, as well as being of value to clinicians treating AD sufferers. If perspective taking of others is among the first cognitive abilities to decline in AD patients then a difference could be observed in their moral algebra. Indeed, the value given to the intent of the actor relying on perspective taking would be less important in the AD group than in the typical group. In addition, the lack of perspective taking would also lead to a difficulty to take the perspective of the victim or the potential victim. Therefore, the AD participants would not discriminate the different levels of the seriousness of the consequence as much as the typical participants.

Moral Judgement in Alzheimer Patients

In order to better understand how the cognitive process involved in moral judgment is affected by ageing, Fontaine, Salvano-Pardieu, Renoux and Pulford (2004) compared blame judgements of patients with Alzheimer's disease (AD) with their typical counterparts.

It was shown that the moral judgements of the AD population differed from the moral judgements of the typical population. They suggested that at least two structures are involved in the moral judgement: one that remains stable throughout

the illness while the other is affected and ceases to operate. Indeed, Fontaine et al., (2004) observed in early-stage Alzheimer patients that their judgment of blame was affected by the deterioration of their others-perspective taking ability, a recognized Alzheimer symptom. By contrast the cognitive ability of these patients to understand what is allowed or not and to judge according to social rules and deontic reasoning remains preserved. Using Anderson's methodology, Fontaine et al., asked participants to judge the actor's behavior in 12 vignettes describing situations of social interaction between two protagonists. Each vignette contained: (a) the degree of intent of the actor (intent vs no intent) and (b) the presence of the consequences of the act (consequence vs no consequence). In addition, three different levels of seriousness (low, medium, high) were displayed through the story: a) the "Push" story illustrated the low level of consequence, (the victim falls on the floor because of a push which causes his nose to bleed) b) the "Burn" story illustrated the medium level of consequence (the victim's hands are burned by a hot skillet) and c) the "Shot" story illustrated the high level of consequence (the shot wounds the victim's leg deeply). Simple and concrete descriptions of daily life events that are easy to understand and memorize, were chosen for this experiment. Under each text, was a 25-cm response scale with two extremes: "no blame" as the left anchor and "very severe blame" as the right anchor. Participants had to put a cross on this scale to record the degree of blame they apportioned to the perpetrator.

The results showed that Alzheimer patients and control group issued identical judgments when both intent and consequence were observed. However, when the consequence was absent, the two groups apportioned blame differently. Indeed, when the aggressor acted deliberately with a bad intent but without a negative outcome (i.e. without harm to the victim), the seriousness of the potential harm to the victim does not influence the Alzheimer patients' judging process. They apportion equal blame to an aggressor failing to burn his victim with a hot skillet and an aggressor failing to shoot her. According to Fontaine et al. (2004) this difference between the moral algebra (i.e. the combination of Intent and Consequence) of both groups is supporting evidence that both deontic reasoning and perspective taking ability are involved in moral judgment. Deontic reasoning operates in the judgment of stories, which either display deliberate intent and an adverse consequence or accidental action without consequences. For these stories knowledge of social rules and precepts is sufficient to judge the situation: deliberately harmful actions resulting in an adverse consequence require blame and accidental actions without a consequence do not require blame. This principle learned in early life, is the basis of social rules. In contrast, when bad intent is present and consequence absent, an accurate judgment

process requires imagining the aggressor's harmful aim and the possible damage attached to it, that is to say perspective taking ability. When the action is accidental but results in a bad consequence perspective taking is also necessary to understand the actor did not act on purpose even though an adverse consequence is observed. This result could also be explained with the dual system: deliberate harmful action would activate system "1": involved in emotional, intuitive and deontological judgements and accidental action without harm would not activate the system so no blame would be observed. Negative intent that does not lead to a bad consequence or accidental action leading to a harmful consequence requires one to take into account the perspective of the other and ToM. In this case, system "2" is involved and a cognitive, rational and utilitarian judgment is required to appreciate the situation and blame the actor according to his intent. With the onset of Alzheimer's disease, system "1" would be preserved while system "2" would become deficient (Fontaine et al., 2004).

As shown previously, ToM is a component of moral reasoning allowing the understanding of the perspective of the other and therefore the intent in social interactions, this component begins to decline at the early stages of Alzheimer's disease and is also associated with a decline in system 2 functioning.

In order to continue the analysis of the dual system, and to further investigate the implication of ToM in moral judgment, Salvano-Pardieu, Blanc, Combalbert, Pierratte, Lepeltier, Manktelow, Gimenes, Barthelemy, Maintier and Fontaine (2016) compared the moral judgments of individuals with and without impairment in ToM. Indeed, individuals impaired in ToM would not be able to take into account the intent of the actor, nor the level of seriousness of the consequence as much as typically-developed individuals. By contrast, they would be able to take into account the consequence of the action which is objective and would be able to evaluate when taking the perspective of the actor is not required. In addition, to target theory of mind in moral judgment, it was crucial to compare populations only on this component and to match individuals with the same intellectual development. Therefore, comparing typically developing adolescents who have achieved the theory of mind with adolescents with Asperger's Syndrome (AS) who are impaired in ToM but are not delayed in their intellectual development, would allow one to investigate the role of ToM in moral judgment.

Teenagers with Asperger's Syndrome (AS)

The assumption developed previously by Fontaine et al., (2004) that at least two different cognitive structures are involved in the moral judgment, one based on deontic reasoning and social rules referring to system 1, and the other on perspective

taking of others and theory of mind (ToM) referring to system 2, was confirmed by a study with Asperger Syndrome (AS) and typically developing (TD) teenagers. In this study, using the same methodology as Fontaine et al. (2004), Salvano-Pardieu, et al. (2016) analyzed the judgment of blame of 13 year old adolescents. The participants had to apportion blame to the perpetrator in the case of 12 vignettes describing social life interactions between two protagonists; specifically, the behavior of the actor according to his intent (deliberately harmful vs accidental), the presence of an adverse outcome (with vs without) and the seriousness of the outcome (low, medium and high). The level of seriousness was displayed within the story: The low level "Push" described a push with the consequence of a bruised knee, the medium level "Punch", a punch with a consequence of a broken nose and the high level "Stab" described a stabbing in which the consequence was a deep wound to the leg. Four vignettes were devised for each story: 1) Deliberate action with an adverse consequence, "Intentional harm" 2) Deliberate action without consequence, "Attempted harm" 3) Accidental action with an adverse consequence "Accidental harm" and 4) Accidental action without consequence, "No harm".

If a part of the blame judgement relies on deontic reasoning and another part on ToM and on perspective taking ability, then participants impaired in ToM and perspective taking ability such as those with AS, would give significantly less weight to intent and significantly more weight to consequence than typically developing (TD) teenagers. For instance, judging the intent of the actor requires perspective taking ability especially if the negative intent does not induce an adverse consequence "Attempted harm". In contrast, judging the consequence does not require perspective taking, consequences being an objective and visible fact. The results reveal that adolescents with and without AS judged intent and consequence in a very different manner. While both groups were able to judge an action by taking into account the actor's intention and the action's consequence, thus corroborating previous results (Grant et al., 2005; Rogé & Mullet., 2011), it was clearly observed that the AS teenagers gave less importance to the intent factor than the TD teenagers. The AS teenagers, took into account bad intent, only if the adverse consequence was observed. In the other situations: bad intent without adverse consequences "Attempted harm" or accidental action with an adverse consequence "Accidental harm", they did not blame the action on the basis of intent but on the basis of consequence. In addition, AS teenagers considered intent and consequence as two independent factors, they did not combine intent and consequence in a multiplicative algebra as typical adolescents and adults did. On the contrary, their moral algebra was additive and similar to that of young children under 10 years old. Unlike adolescents with

Asperger's Syndrome, typically developing teenagers judged on the basis of the actor's intention rather than the action's outcome and were able to combine intent and consequence in a multiplicative moral algebra as already proven by many studies (Przygotzki & Mullet, 1997; Turiel, 1998; Rogé & Mullet, 2011; Moran et al., 2011). Salvano-Pardieu et al. (2016) have also observed that typical teenagers increase the severity of their blame with the seriousness of the adverse outcome: the greater the seriousness of the outcome, the greater the blame. This difference between the three levels of seriousness of the outcome is not observed with the AS group who judge with the same severity the two highest levels of seriousness. This result is congruent with previous research (Zalla et al., 2011), which demonstrated that adults with high functioning autism (HFA) or Asperger's Syndrome (AS) failed to distinguish between moral transgressions with different levels of seriousness. Adolescents with autism are able to judge an action by taking into account the intention of the actor and the consequence of the action but impairment in the perspective taking of others seems to hold them to the typical moral algebra of younger and still egocentric children relying on an additive consequence-focused pattern as well as an inaccurate representation of the seriousness of the consequence. This inaccurate representation of the consequence's seriousness could explain the misunderstanding of certain social situations and the dangers attached to them.

This difference in the moral algebra between AS and TD teenagers, supports the suggestion of Fontaine et al. (2004) that at least two different cognitive components are involved in moral judgment: one based on ToM and the other on deontic reasoning. Deontic reasoning seems to be preserved in adolescents with AS which explains their ability to perceive what is allowed or not in a given social context. They are consequently able to judge deliberate actions with adverse consequences and accidental actions without consequences in the same way as TD adolescents or adults. By contrast, their impairment in ToM and perspective taking ability prevents them from understanding the victim's perspective and therefore blaming an action according to the perpetrator's intent. Therefore, blame is not apportioned in the "Attempted harm" situation while in the "Accidental harm" situation severe blame is apportioned. The difficulty to take into account the intention of the actor and the perspective of the victim or potential victim in social interactions was observed with the AS Adolescents and the Alzheimer patients, but this difficulty was enhanced with AS teenagers impaired on ToM. These last studies highlight the role of the perspective taking of others in the judgement of blame and its evolution with the different stages of development. This cognitive ability allows individuals to understand the motives of an actor and determine if their action is perpetrated deliberately or accidentally and adjust accordingly their answer to the social situation.

According to the properties of the dual system, one could consider that a judgment based on the consequence activates a quick and spontaneous judgment (system "1") while a judgment based on the intent requires reflection and the ability to think about what the other person is thinking in order to appreciate the seriousness of the aggression. This judgment would require the activation of system "2" which is found impaired with AS teenagers.

Children and Teenagers With Intellectual Disability

In order to further analyze the different structures of moral judgment and to study how the different components of the dual system and ETIC model are integrated with age and intellectual development, Salvano-Pardieu, Oubrahim, Galvani, Kilpatrick & Combalbert (2019) compared the moral judgments of children and adolescents with Typical Development (TD) with those of mild Intellectual Disability (ID). Understanding how these components are affected by intellectual disability as well as their role in social interactions would help to prevent social difficulties that ID children and adolescents struggle with. The authors assume that if the cognitive abilities involved in moral judgment such as ToM or inhibitory control depend on intellectual development and if intellectual development is delayed, then, these components should also be delayed and, therefore, this delay should be observed in the moral algebra of ID participants. As their reasoning is more egocentric and at a lower stage of development than TD participants, ID participants will focus more on the consequence than on the intent. ToM would be expected to be delayed in ID participants and, therefore, they would be less able to take the perspective of the other than TD participants, especially in situations with a strong implication of ToM such as the "accidental" and "attempted" harm scenarios.

According to the DSM 5 (2013), intellectual disability (ID) involves impairments of general mental abilities that impact adaptive functioning in cognitive abilities (skills in various fields, namely language, reading, writing, mathematics, reasoning, knowledge and memory) and social abilities (empathy, social judgement, interpersonal communication skills and the ability to make and maintain friendships). Individuals with ID are more or less delayed in their cognitive and social development according to their level of intellectual disability. Although there are very few studies about moral judgement of people with ID, some research has highlighted that children and teenagers with ID remain egocentric longer than their typical counterparts (see Langdon, Clare, & Murphy, 2010 for a review).

In this study the method was the same as that in the previous study with AS teenagers (Salvano-Pardieu et al 2016). Participants had to read 12 vignettes were four scenarios with three different levels of aggressiveness were presented. Each

scenario was presented with a 16 cm response scale with two ends: "no blame" as the left anchor (0 cm) and "very severe blame" as the right anchor (16 cm). Participants had to tick a notch between "0" and "16" to record their judgment.

Participants were divided into four groups (31 by group): children of 9 years old and adolescents of 13 years old with mild intellectual disabilities (ID) and children of 9 years old and adolescents of 13 years old typically developing (TD).

The results showed that the TD group blames the intention of the actor much more than the ID group. This result confirms that perspective taking ability is delayed in the ID participants' moral judgements. In addition, typically developed adolescents blame the intention of the actor much more than typically developed children do. This result is congruent with previous findings and confirms that ToM and therefore the perspective taking of the other are not developed in children as much as in adolescents. These cognitive structures, even if they emerge around 4-5 years of age (Wimmer & Perner, 1983), need time to develop and allow children to focus on the intent when judging social interactions (Valle et al., 2015). Even if the cognitive abilities of the ToM develop early enough, using them as part of a moral judgment would be a more expensive process in cognitive resources and therefore would be more likely observed later in development.

In contrast, ID participants blame the outcome of the action much more than the TD participants, and TD children blame the outcome of the action much more than TD adolescents. This confirms previous findings reporting that children give more weight to the consequence of the action and less weight to the intent than teenagers (Cushman et al., 2013; Rogé and Mullet, 2011). This result is also congruent with the assumption that deontic reasoning and emotional arousal attached to the consequence of the action are involved in the evaluation system of the outcome of the action. In addition, a comparison of the moral algebra of the ID and TD groups shows that these two groups blame "intentional harm" situations the most harshly and "no harm" situations the most leniently. The pattern of responses between TD and ID groups is very similar in these two situations, as well as the pattern of responses between TD children and TD teenagers. In these situations, deontic reasoning seems sufficient to blame the action according to its outcome. This result could be explained by the congruent output of the dual system. Indeed, in deliberate harm situations, system "1" evaluates the consequence, and the presence of a negative consequence leads to activation and blame is given to the aggressor. At the same time system "2" is activated by the intent that requires ToM. System "2" evaluates the bad intent that also leads to blame the aggressor. Therefore, the two outputs of the dual system are congruent because they lead to the blame of the aggressor. This also explains the

similarity of the moral algebra between TD and ID participants and between TD children and TD adolescents in this situation. By contrast, in the situation without bad intent and without negative consequence, the dual system is activated neither by the adverse consequence nor by the negative intent. Because no harm is observed, the judgement result is no blame. Again, the two outputs of the dual system are congruent: both are not activated. Therefore, the judgment is very similar between TD and ID participants and between TD children and TD Adolescents.

By contrast, in the "attempted harm" situation, the ID group attributes much less blame to the actor than the TD group. This effect is even emphasized with TD adolescents. This result is congruent with the dual-process model (Cushman 2008, 2013) and the ETIC model (Buon 2016). For the attempted harm situation the output of the dual system shows that the intent and consequence of the action are in competition since only the intention evaluation system is activated. Indeed, the output of the system based on the intent of the aggressor is activated, the aggressor wants to harm, while the output of the system based on the consequence is not activated since no harm is observed. The results also confirm that with ID individuals the intent of the actor is not taken into account as much as the outcome of the action. This suggests children and ID groups judge the attempted harm situation according to the consequence and blame leniently the actor since no 'bad' action was perpetrated. This result also suggests that judging the outcome of the action is easier and quicker than judging the intention of the actor based on ToM. This result is congruent with previous studies, showing that individuals use information about the outcome of action to judge the intention of the actor. Indeed, Knobe (2005); Leslie, Knobe & Cohen (2006); Petit & Knobe (2009); Killen, Mulvey, Mulvey, Richardson, Jampol & Woodward (2011) have observed that individuals are more likely to think that an action is deliberate with negative intent when the outcome is negative but, in contrast, are more likely to think that the intention is neutral when the outcome of the action does not lead to a negative consequence. Again, this result confirms the hypothesis that the system evaluating the intent of the actor is slower, based on ToM and develops later than the system evaluating the outcome of the action.

Finally, in the "accidental harm" situation, results show a clear difference between ID and TD groups and between children and adolescents. While TD participants blame only leniently the accidental action, in contrast ID participants blame this action more harshly. Likewise, adolescents blame more leniently accidental action than children. This, congruent with previous results on the "attempted harm situation", suggests that children and ID participants are focused on the consequence of the action and not on the intent. This result confirms that when the outputs of the dual system are in

opposition, the system evaluating the intent supported by ToM is weakly activated in the ID individuals and in children, suggesting that ToM develops later than deontic reasoning and remains immature with TD children and with ID individuals. It also suggests that the cognitive delay of the ID individuals has a consequence on moral development especially on ToM and perspective taking of the other. Therefore, the evaluation of intention in the dual system based on ToM seems to be linked to intellectual development. In addition, according to Buon et al (2016), inhibitory control, (a component of the "ETIC" model), would allow the reduction of emotional arousal activated by the consequence of the action if for example, the consequence is as serious as an injury. In the accidental harm situation, the inhibitory control would allow a focus on the intent and a lower blame. One can assume that this inhibitory control would not be activated or only faintly with ID participants since they condemn the "accidental harm" situation and take into account the consequence of the action more than the neutral intent unlike typically developed participants. This effect observed mainly with ID children, suggests that the development of the cognitive structure supporting inhibitory control is also delayed with ID individuals. This immaturity of the moral judgment structures with children, and more so with children with mild intellectual impairment is also observed in their difficulty in judging different levels of aggressiveness within social interactions. Indeed, it has been assumed that the interaction between perspective-taking and ToM could be observed in different social interactions with different levels of aggressiveness. In order to determine how the level of the aggressiveness impacts the components of the dual system, we compared the level of blame in situations with low, medium and high levels of aggression.

As hypothesized, children with intellectual disabilities have difficulty taking into account, as accurately as adolescents with ID and typically developed children and adolescents, the three levels of aggressiveness of the action when they judge aggressiveness in social interactions. By contrast, typically developed children and teenagers with intellectual disabilities can appreciate the seriousness of the different situations of social interaction and blame the actor accordingly. A push resulting in a bruised knee is judged less blameworthy than a punch resulting in a broken nose, which in turn is blamed less than a stabbing resulting in a seriously wounded leg. Unlike children with ID, adolescents with ID are able to discriminate between the "Knife" and the "Punch" story.

This result suggests that the perspective-taking ability is not impaired but delayed in individuals with ID. Indeed, the group of children with ID blames more severely the "Push" story than all the other groups and does not take into account

the aggressiveness of the action as accurately as the group of teenagers with ID. This result confirms that ToM and perspective-taking abilities develop later in individuals with ID than in TD individuals. For this reason, ToM can be observed among ID teenagers who have more cognitive maturity and experience of social interactions, but is not observed among ID children.

The immaturity of the structure of moral reasoning could lead to a misunderstanding and a wrong interpretation of social interactions and explain why a higher level of aggressiveness in social behavior is observed with intellectual disabled children and teenagers.

In a recent study, devised to investigate the relationship between, intellectual disability, aggressive behaviour and moral judgment, Oubrahim, Combalbert & Salvano-Pardieu (2019) compared the moral judgments of aggressive children and adolescents with those of non-aggressive children and adolescents; all participants had a learning difficulty. They assumed that the less aggressive and more prosocial individuals would attribute most blame to the intent of the actor and the least blame to the consequence of the action. In addition, the less aggressive individuals would present the greater level of inhibitory control (Crick and Dodge, 1994; 1996; Monks, Smith and Swettenham, 2005). The level of inhibitory control can be observed in the judgment on the accidental harm situation. The less aggressive individuals would be expected to show more leniency in this situation since the intention is not to harm and the actor did not act deliberately.

Moral Judgement and Aggressive Behaviour

In this experiment (Oubrahim et al. 2019), the level of aggressiveness of the participant was measured using the Behaviour Problem Inventory Short Form (BPI-SF) scale (Rojahn, 2011). The BPI is a structured interview conducted by a professional, which consists of 30 items representing behaviour problems in people with ID. The BPI scale is divided into several subscales. The subscales of "self-injurious behaviours", "aggressive and destructive behaviours" and "stereotyped behaviours". The BPI-SF assesses the frequency and intensity of behaviour problems existing during the two months before the evaluation. The frequency is evaluated on a scale from 0 to 4, either never (0), monthly (1), weekly (2), daily (3), every hour (4) and a severity scale from 0 to 3, either (1) mild, (2) moderate or (3) severe. ID children and ID adolescents with a frequency score of "0" were included in the "non-aggressive" group and those with a score above "0" were included in the "aggressive" group. Moral judgment was assessed with the same 12 vignettes described previously (Salvano-Pardieu et al.,

2016). The findings showed that among children and teenagers with mild intellectual disability, the most aggressive were the less able to take into account the intent of the actor. They were focused on the consequence of the action much more than on the intention of the actor. For example, in the "attempted harm situation" they blame the aggressor leniently while in the "accidental harm situation" they blame the actor more severely. The more severe blame attributed in the "accidental harm" than "attempted harm" scenarios was particularly pronounced with the aggressive children. Unlike aggressive children and adolescents, non-aggressive participants were able to take into account the intention and blame to the same degree when judging the "attempted harm" situation and the "accidental harm" situation. This result was even stronger with non-aggressive adolescents. This study is congruent with previous research leading to the conclusion that people with aggressive behaviour, have difficulty understanding social situations, particularly the intent of others (Crick & Dodge, 1994; Rothier & Fontaine, 2003), independent of one's intellectual level. Indeed as observed previously, children and teenagers with mild intellectual disability have difficulty understanding the intention of the actor, and appear to base their judgment on the consequence using system "1" more than on the intention and system "2". However, non-aggressive children and teenagers with ID, show a better understanding of social situations, including the intent of others, even if they cannot blame social interactions in the same way as typically developed children and teenagers. Therefore, the dual system involved in moral judgments appears to be influenced by the age, the intellectual development and the level of aggressiveness of the individual.

Moral Algebras and Cognitive Maturity

Salvano-Pardieu et al. (2016, 2019) analyzed the moral algebra of children and teenagers with and without intellectual disabilities and adolescents with and without Asperger Syndrome. Their findings showed that the different groups of children and adolescents employ different moral algebras. Typically developed teenagers,, show greater effect sizes for intent with all stories (i.e. low, medium and high levels of aggressiveness) compared to the effect sizes for consequences, and they are able to weight intent with regards to the presence or absence of a negative outcome.

They do not consider intent and consequence as two independent factors, but rather modulate the weight given to intent and to the consequences to achieve, for each level of seriousness, an interaction between these two factors. This result is congruent with previous findings on moral development (Przygotzki, & Mullet 1997)

which have shown that "multiplicative" algebra is usually observed with typical teenagers and adults. In contrast, children with ID and AS teenagers produce, for the three stories, a greater effect size for the consequence than for intent and they never modulate the weight of intent and consequence; that is, each factor, intent and consequence, is considered independently. This result concurs with previous studies that have reported an "additive" algebra as typical of the moral judgements of children (Anderson, 1996).

Finally, children typically developed and teenagers with ID present a pattern of response between these two extremes. Children of the control group present a multiplicative moral algebra for the lowest and highest level of aggressiveness and an additive moral algebra for the medium level of aggressiveness.

In addition for both groups of children this difference between consequence and intent increases with the level of aggressiveness. In the "Push" story, typically developed children were able to judge more harshly "attempted harm" than "accidental harm". This result confirms that typically developed children are able to take into account the intent of the actor and to inhibit emotion in the "accidental harm" situation, when the outcome is not serious and the emotional arousal is low. Therefore, children are in a developmental stage in which they start to be able to take into account the perspective of another in a moral judgment situation where intent of the agent and outcome of the action are in conflict.

Adolescents with ID presented a multiplicative algebra only when the level of seriousness was the highest i.e. the "Knife" story. In this story, one can assume they realize that the aggressiveness of the action is so serious that they blame more harshly the intent of the actor even if it is not followed by a negative outcome. However, except for the "knife" story which produced similar effect sizes for both intent and consequence, for the other levels of aggressiveness, "Push" and "Punch" stories, the effect size of the consequence is greater than the effect size of intent.

Teenagers with ID and TD children present a moral algebra which takes into account the intent and demonstrates better perspective taking ability than children with ID and AS teenagers, while still not as developed as TD teenagers. This result confirms that ToM is delayed in ID individuals and supports previous findings (Gargiulo and Sulick, 1978; Kahn, 1985). Gargiulo and Sulick (1978) have shown a trend in which children without ID score higher on moral reasoning than participants with ID and participants with mild ID score higher than participants with moderate ID. Kahn (1983) added that children with mild ID have significantly higher moral reasoning than adolescents with moderate ID. This result has been confirmed by van Vugt et al. (2011). In their experiment comparing the moral judgments of young sex offenders with and without ID, the authors found that the sex offenders with ID were at a lower moral stage than the sex offenders without ID.

CONCLUSION

In this chapter the roles of the different components of moral judgement, such as deontic reasoning, ToM, emotion and inhibitory control have been discussed. These components were analyzed in terms of a dual judgment system. This dual system is composed by an emotional, quick, spontaneous system involved in the evaluation of the consequence of the action, and mainly based on deontic reasoning and by a slow, reflexive, utilitarian system involved in the judgment of the intent of the actor, mainly based on ToM. These different components were also analyzed from Anderson's social information integration theory that proposes a moral algebra: a combination of different factors such as intent and consequence and the weight associated with each of these factors.

The studies presented in this chapter have confirmed the role of a dual system, with the implication of at least two main components: one based on social rules and deontic reasoning, and another based on ToM and perspective taking ability. These two components seem to develop differently following age and intellectual development. On one hand, deontic reasoning appears early in development and is involved in the evaluation of an action and its consequence. This explains why very young children, around 3 years old, are able to judge the consequences of an action. On the other hand, ToM appears later in development and is involved in the evaluation of the intent of the agent. This last component, impaired in autism spectrum disorders and delayed in intellectual disabilities, is dependent on intellectual development. ToM also appears to be involved in the ability to evaluate the level of aggressiveness of an action. This would explain why young children, children with intellectual disabilities and adolescents with Asperger Syndrome have difficulties appreciating and understanding different levels of aggressiveness in social interactions.

Finally, two other components: emotional arousal and inhibitory control modulate the action of the dual system. Emotional arousal reinforces the action of the system involved in judging the output of the action; increasing or decreasing the level of blame as a function of the consequence of the action. Inhibitory control, involved in the judgment of accidental harm situations, would facilitate the action of the system evaluating the intention by inhibiting the emotion resulting from the visible harm the action produces. This component seems to develop later than "emotional arousal" and "deontic reasoning" in the moral judgment pattern and likewise ToM ability, and is impaired in autism spectrum disorders and Asperger's Syndrome and delayed in intellectual disabilities.

The research presented in this chapter paves the way to a better understanding of the cognitive structures underlying moral judgement. Identifying the fundamental cognitive structures and their way of operating will enable us to deliver help to patients with pathologies and individuals with learning and behavioral difficulties offering them more independence in their social lives.

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Chapter 3
The Reasoning Process: What Is It? What Is Its Purpose? How Does It Function? A Link With Emotions

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ABSTRACT

What does "reasoning" mean? What is its purpose? And, how does it function? This chapter defines reasoning and the distinction between deductive and inductive reasoning. Secondly, the argumentative theory of reasoning proposed by Mercier and Sperber (2011) is presented to understand the purpose of the reasoning. This theory postulates that its function is to convince others and to evaluate information received when someone tries to convince another. Thirdly, the authors focus on the intervention model of reasoning developed by Evans (2011) to try to understand how the reasoning functions. This model is derived from dual-process theories and proposes a distinction between two types of processing in reasoning. The last part explains the importance of considering the emotional factor in the study on the reasoning process.

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INTRODUCTION

Before trying to understand why and how people reason, it seems necessary to understand what is the reasoning. After a definition of the reasoning, the authors will present first the argumentative theory of reasoning (Mercier & Sperber, 2011), which concerns the purpose of reasoning and sheds new light on errors of reasoning. This theory postulates that the function of reasoning is not to discover a rational truth but rather to find arguments supporting our point of view or decision in order to convince others, and to evaluate and filter information we receive when someone tries to convince us (Mercier & Sperber, 2011).

Secondly, the authors will focus on the intervention model of reasoning (Evans, 2011) derived from dual-process theories. This model proposes a distinction between two types of processing in reasoning: Type 1, which leads to the formulation of an initial intuitive conclusion, and Type 2, which is always involved but whose effectiveness depends on individual or task characteristics. Details about this model and Type 1 and Type 2 will be presented in this part.

To conclude, this chapter will present research on the link between emotion and reasoning. Although emotions do not appear in the reasoning model proposed by Evans (2011), many studies indicate a strong link between these two processes throughout development (Amsterlaw, Lagattuta, & Meltzoff, 2009; Blanchette & Campbell, 2012; Blanchette, Lindsay, & Davies, 2014; Eliades, Mansell, Stewart, & Blanchette, 2012; Muris, Merckelbach, & van Spauwen, 2003; Schwarz & Bless, 1991; Tricard, Maintenant, & Pennequin, 2018)

WHAT DOES "REASONING" MEAN?

A Definition of Reasoning

Used in many everyday situations (e.g. to convince someone, to solve a problem or to demonstrate a point), reasoning is defined as "*the mental activity used to produce an argument or to assess the conclusion or proof of the argument*"[1] (Rossi & Van Der Henst, 2007, p. 26). First and foremost, reasoning involves making an inference in order to draw a conclusion from the multiple elements of a situation, and then to evaluate its validity. In psychology, inference refers to the ability to draw a conclusion from elements of the situation that are already knows (the premises).

First, based on Rossi and van der Henst's definition (2007), reasoning is the mental activity underpinning this activity, in other words, the cognitive process. There are many theories of human reasoning. In this chapter, the authors focus on

dual-process theories, which provide a framework to understand systematic bias in human reasoning, particularly in adults, and the mechanisms used to override non-normative responses. These theories aim to explain how people reason. The definition above also raises the question of the purpose of human reasoning, namely to produce or assess a conclusion. From an interactionist standpoint, reasoning has an argumentative function: its purpose is not only to communicate, to convince and persuade other people, but also to evaluate the relevance and coherence of arguments to avoid falling into the trap of a fallacious argument. The argumentative theory developed by Mercier and Sperber (2001) provides an explanation of why human beings reason.

Taking up Rossi and van der Henst's (2007) metaphor of a tapestry, the argumentative function of reasoning is its visible aspect, the tapestry's pattern, while the cognitive process underpinning this mental activity is like the back of the tapestry.

The study of reasoning is a very large field of research, and researchers have tended to focus on specific areas, such as particular tasks (e.g. the Wason selection task: Grosset, Barrouillet, & Misuraca, 2004; Noveck & O'Brien, 1996; Wason, 1968), particular types of error (e.g. the belief bias: Eliades, Mansell, Stewart, & Blanchette, 2012; Markovits & Nantel, 1989; Morley, Evans, & Handley, 2004), the influence of a specific factor on reasoning performance (e.g. the emotional factor: Blanchette & Leese, 2011; Eliades, Mansell, & Blanchette, 2013; Tricard, Maintenant, & Pennequin, 2018), or, more recently, the neural process underlying the reasoning activity (Leite, Barker, & Lucas, 2016; Modi, Kumar, Nara, Kumar, & Khushu, 2018). However, some authors have taken a broader approach, bringing together different kinds of inferential reasoning (George, 1997). For example, Johnson-Laird (1983) identified three kinds of inference (deductive, inductive and other types), leading to a large number of studies on performance and errors in specific tasks. While the Bayesian approach called this classification into question, suggesting that the uncertainty degree associated with premises and conclusions should be taken into account, some authors continue to highlight the relevance of the deductive/inductive distinction (Evans & Over, 2013).

Deduction and Induction

The aim of deductive inferences is to establish the validity of a conclusion based on the use of premises, which involve general knowledge, by applying rules of logical reasoning. Deductive inferences use something known, in other words knowledge of the premises, to draw firm conclusions about a given situation. This process is

not used to improve knowledge but to make explicit something that was implicit in the premises. By contrast, inductive inferences involve generalizing observations or concrete cases to establish a general rule that is relevant in other similar cases. Induction improves knowledge and enables us to make predictions about something new and uncertain (the conclusion) from something we already know from personal observations or concrete cases (the premise) (Manktelow, 2012, p. 156-157).

For deductive reasoning tasks, a distinction needs to be made between the validity of the conclusion based on formal logic (e.g. all horses eat hay / this animal is a horse / therefore this animal eats hay) and credible conclusions based on everyday logic. A conclusion could be true according to formal logic but unbelievable (e.g. all mammals walk / whales are mammals / therefore whales walk) or false according to formal logic but believable (e.g. all flowers have petals / roses have petals / therefore roses are flowers). Studies on deductive reasoning tasks use this conflict between formal logic and everyday logic to evaluate participants' performance. Normative (correct) responses are those that follow the rules of formal logic without taking into account the credibility of the conclusion (Table 1). Other responses are considered as errors or reasoning bias. Thus, the conclusion of inductive reasoning is evaluated in terms of its probability of being true, while the conclusion of deductive reasoning is normative, but not necessarily believable, if it follows the rules of formal reasoning.

Although these two inferential approaches - deductive and inductive - seem to be opposed, they actually apply to different situations (figure 1): reasoning about a particular case to derive a general law (inductive reasoning), and the application of general laws to understand a particular case (deductive reasoning).

Figure 1. Difference between deductive and inductive reasoning

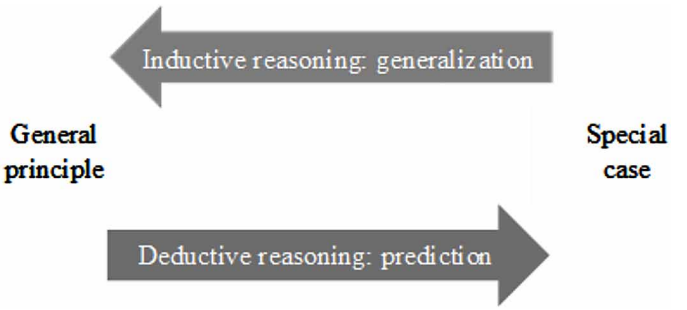


Table 1. Truth tables for differing propositional connectives

Connective	Logical Form	Linguistic Form	*p q*	Truth of Rule
Material implication	p ⊃ q	*If* p *then* q or p *only if* q	TT	T
			TF	F
			FT	T
			FF	T
Material equivalence	p ↔ q	*If and only if* p *then* q	TT	T
			TF	F
			FT	F
			FF	T
Conjunction	p ∧ q	p *and* q	TT	T
			TF	F
			FT	F
			FF	F
Inclusive disjunction	p ∨ q	p *or* q (or both)	TT	T
			TF	T
			FT	T
			FF	F
Exclusive disjunction	p / q	p *or* q (but not both)	TT	F
			TF	T
			FT	T
			FF	F

Note. T = true ; F = false

WHY DO HUMAN BEINGS REASON? A REVIEW OF THE ARGUMENTATIVE THEORY OF REASONING

The argumentative theory of reasoning provides an answer to a recurring enigma in the field of reasoning: why are we so good at reasoning in certain situations but bad in others? According to Mercier and Sperber (2011), the answer lies in the purpose of reasoning, which is not to increase knowledge or choose the best option, but to argue one's point of view to convince others. It is not a search for truth that motivates reasoning but the desire to persuade other people. Amongst other things, this explains the confirmation bias, which is the tendency to seek or interpret evidence "in ways that are partial to existing beliefs, expectations, or a hypothesis in hand" (Nickerson, 1998). When individuals reason proactively, their errors are due to their desire to find an argument validating the conclusion. Reasoning thus

has three functions: to justify our actions, to convince others, and to evaluate the relevance of the reasoning of others.

Thus, reasoning is most effective when two or more people try to resolve a disagreement. Indeed, it is this situation that best illustrates the hypothesis that the purpose of reasoning is to use arguments to convince others. However, research on reasoning typically involves asking individuals to produce or evaluate the logical validity of a conclusion; as no-one argues or tries to persuade them, it is difficult to activate reasoning, and performance is poor (Evans, 1989, 2002). By contrast, when a group has to solve the same problem, each member of the group has to activate and implement a reasoning process in order to find arguments and suggest a solution or to evaluate those put forward by the others. In this case, participants who find the right answer and can justify it will see their reasoning prevail (Maciejovsky & Budescu, 2007; Moshman & Geil, 1998). In a series of studies using Wason's card selection task (Wason, 1966), Maciejovsky and Budescu (2007) proposed an auction situation, with participants working alone and then in groups of four, either competitively or collaboratively. They were presented with a conditional statement of the form "*if P then Q*" (figure 2) and had to choose the right card or combination of cards to check if the rule was true. If the choice was correct, the participant received a pay-off, if not, the stake was lost. Participants could see the choices they made in the last three trials on a computer screen, together with those made by their opponents / collaborators. The results of these experiments indicate that the success rate in reasoning tasks is significantly higher when participants work in groups than alone, whether the group operates cooperatively or competitively. It seems that these skills are transferable to other tasks (Maciejovsky & Budescu, 2007).

Although the theory of the argumentative function of reasoning provides essential tools for understanding widely observed errors of reasoning, it does not tell us about the underlying mechanisms. In other words, how do people reason? Thus, other research has focused on the mechanisms of reasoning, in other words, the processes used to draw a conclusion from a situation or evaluate the arguments given by other individuals.

Figure 2. Example of statements proposed in the study by Maciejovsky & Budescu (2007)

	Cards			
Stage I:	**I**	**II**	**III**	**IV**
I. If the card is striped on one side, then there is a square on the other side (I, IV)				

HOW DO PEOPLE REASON? A REVIEW OF DUAL-PROCESS THEORIES

Due to the varied nature of the terms used and topics studied in the psychology of reasoning (logical connectors, Wason's task, syllogisms, initial beliefs, biases, etc.), researchers have sought a unifying theory to explain the results of studies. According to Andler (2004), for a theory of reasoning to be judged satisfactory, it must be able to meet four imperatives: (a) explain human skills, (b) explain the many errors made by individuals, despite increasing age and success in similar tasks, (c) explain the distribution of these errors, which is neither uniform nor a mere reflection of the apparent complexity of the task, and finally (d) explain the influence of the content of the task and the context.

Finally, two approaches to reasoning have emerged: the nativist approach, based on the idea that the capacity to make logical inferences is innate (Braine, 1990), supported by research showing that reasoning skills emerge at a young age (Dias & Harris, 1988; Hawkins, Pea, Glick, & Scribner, 1984); and the empiricist approach, defended by researchers who argue that reasoning is the result of experience and learning (Cheng & Holyoak, 1985). However, dual-process theories, bringing together these two schools of thought, have proved the most popular, due to their explanatory power with respect to the functioning of reasoning.

The distinction between two ways of reasoning, one fast and intuitive and the other slow and deliberate, is not new. However, although there is a substantial body of work on the subject, there has been little communication between researchers in different disciplines (Evans & Frankish, 2009). It has been studied in areas including high-level cognitive processes such as reasoning, decision-making, judgement including moral and ethical judgment (Evans, 1989, 2007, 2008; Evans & Over, 1996; Kahneman, 2011; Kahneman & Frederick, 2002; Sloman, 1996; Stanovich, 2011; Stanovich & West, 2000; Wason & Evans, 1975), the psychology of learning (Dienes & Perner, 1999; Reber, 1989; Sun, Slusarz, & Terry, 2005), or social cognition (Chaiken & Trope, 1999; Epstein, 1994; Kruglanski & Orehek, 2007; Smith & DeCoster, 2000). A number of theoretical propositions based on the distinction between two processes have emerged in each area, which explains the variety of names given to the processes: subconscious / conscious; type 1 / type 2; intuitive / logical; heuristic / analytic; system 1 / system 2; automatic / deliberate; implicit / explicit, and so on.

Thus, dual-process theories, although all based on the distinction between two processes, cover a wide variety of models with specific and sometimes distinct characteristics. After presenting the common elements of these theories, the authors will describe in detail the intervention model developed by Evans (2011).

Introduction to Dual-Process Theories

A study by Wason and Evans (1975) marked the beginning of researchers' interest in the possibility of dual processes underlying reasoning performance. That study was based on verification of the abstract conditional rule, presented either affirmatively, *if P then Q*, or negatively, *if P then there is no Q*. Participants had to choose the right card or combination of cards to check if the rule was true. The authors observed that participants made more normative choices (i.e. chose to turn over the right combination of cards: *P* and *not-Q*) when the sentence was presented negatively. When first presented with the negative version, participants try to falsify this negative rule by turning over both *P* card and *Q* card – which is the *not-no Q* card – to check the rule. These choices are corresponding to application of the logical rule of reasoning. However, when they are given the affirmative version, they turn over the same cards (*P* and *Q*), which no longer corresponds to the logical answer, and the justifications given by participants demonstrate a matching bias. To explain the finding that participants were able to reason logically in one situation but not in the other, the authors made two hypotheses linked to a differentiation between two processes, one that is unconscious and leads to a matching bias, and one that is conscious and enables individuals to make a rational and coherent choice.

In 1996, Jonathan Evans and David Over published a book in which they expounded the dual-process theory, using it to explain the belief bias, which is the tendency to accept an argument that fits with our beliefs and knowledge even when it is logically invalid (Evans & Over, 1996). These belief-related responses are attributed to what is known as a heuristic process, whereas examining the logical validity of the conclusion is based on analytic processing. The heuristic process is considered to be responsible for reasoning errors, although it is effective in many situations. Indeed, heuristics are shortcuts which represent an adaptive mechanism that saves time and effort while making daily decisions (Croskerry, Singhal, & Mamede, 2013). Analytic processing leads to the production of logical responses. However, the way these two processes interact or when each Type is used during a reasoning task remains unclear.

This theory has been the subject of much research and has been considerably developed. In the most recent considerations of their theory, Evans and Stanovich used the terms Type 1 / Type 2 to distinguish between these two processes in order to emphasize their underlying qualitative differences. Type 1 is described as predominantly intuitive and autonomous, and it does not require the intervention of working memory. Type 2 is a reflective process, which has a high cognitive cost

and requires working memory (Evans & Stanovich, 2013). According to the authors, these are the characteristics that best differentiate and define these two processes. However, other specific characteristics of the two types of reasoning have been identified and used by some authors, although there is no unanimous agreement. These characteristics can be classified in four categories within the framework of the dual-process theory (Evans, 2008): consciousness of the process; the evolutionary aspect; functional characteristics; the origin of inter-individual differences (Table 2).

The consciousness of the process. The attributes in this category correspond to the differences between the cognitive unconscious and conscious. The cognitive unconscious refers to the mental operations that the individual does not remember having done (e.g., not all the operations required for driving are carried out consciously)

Table 2. Clusters of attributes associated with dual systems of thinking identified by Evans (2008)

Type 1	Type 2
Cluster 1 (Consciousness)	
Unconscious	Conscious
Implicit	Explicit
Automatic	Controlled
Low effort	High effort
Rapid	Slow
High capacity	Low capacity
Default process	Inhibitory
Holistic, perceptual	Analytic, reflective
Cluster 2 (Evolution)	
Evolutionarily old	Evolutionarily recent
Evolutionary rationality	Individual rationality
Shared with animals	Uniquely human
Nonverbal	Linked to language
Modular cognition	Fluid intelligence
Cluster 3 (Functional Characteristics)	
Associative	Rule based
Domain specific	Domain general
Contextualized	Abstract
Pragmatic	Logical
Parallel	Sequential
Stereotypical	Egalitarian
Cluster 4 (Individual Differences)	
Universal	Heritable
Independent of general intelligence	Linked to general intelligence
Independent of working memory	Limited by working memory capacity

and that cannot be explained; a good example is the way subliminal images are processed (Whalen et al., 1998). Conversely, Type 2 is a cognitive process that is conscious, explicit, intentional and controlled. When using this process, individuals can verbally explain their thought process.

The evolutionary aspect of the process. A recurring feature of dual-process theories is that Type 2 emerged later than Type 1 (Epstein & Pacini, 1999; Evans & Over, 1996; Reber, 1989; Stanovich, 1999). This raises a number of issues. First, Type 2 processing is human-specific, whereas Type 1 is also found in animals. However, Toates (2006) suggested that a similar distinction can be observed in some animal species, with reflex processes appearing in response to a situation, as well as more controlled and therefore conscious processes, similar to Type 2. A second issue stems from the work of Jerry Fodor (1983) who developed a theory of the modularity of the mind. According to this theory, modules are innate, specialized and domain-specific processing devices, which work autonomously and encapsulate information, in other words, they do not interact with other modules. Thus, there would not be just one module related to Type 1 processing, but several, and while some may be evolutionarily old (e.g. vision, attention), others have emerged more recently and are more specific to the human species (e.g. language, theory of the mind). These studies raise questions about the distinction between an "old" cognitive system associated with Type 1 and a "recent" cognitive system associated with Type 2.

Functional characteristics. The literature on the functional characteristics of Type 1 and Type 2 processes has often led to the former being seen as concrete and contextualized, in contrast to the latter, seen as abstract and decontextualized. Many studies have linked Type 1 reasoning to prior beliefs and knowledge (Evans, 2006; Stanovich, 1999). However, to consider that Type 2 is by default decontextualized and abstract seems to be flawed (Evans, 2008, 2012), as other characteristics associated with Type 2 (slow, sequential, explicit, rule-based) cannot be limited to abstract and decontextualized processes (Verschueren, Schaeken, & d'Ydewalle, 2005). Thus, contextualized reasoning based on a Type 1 process would be fast, cognitively inexpensive and probably use information unconsciously, and only the conclusion would be consciously accessible. Conversely, contextualized reasoning using Type 2 would involve a conscious search for counterexamples.

Individual differences. As pointed out by Evans (2008), the Type 2 process has often been associated with general intelligence, with the corollary that the Type 1 process would be independent of intellectual ability. In this line, there has been an increasing amount of research on working memory, which is closely linked to general intelligence (Colom, Rebello, Palacios, Espinosa, & Kyllonen, 2004), and

the effect of chronological age. Indeed, the age-related development of intellectual abilities is considered to be a good predictor of reasoning performance, particularly the use of Type 2 processing. However, cognitive abilities are not the only factor influencing the use of one process rather than the other in a reasoning task; for example, cognitive disposition, in other words, a preference to process information either intuitively or analytically, also has a significant effect on an individual's performance (Macpherson & Stanovich, 2007; Stanovich, 1999; Toplak, West, & Stanovich, 2014). In addition, recent research suggests a link between participants' emotional state and their reasoning performance (Amsterlaw et al., 2009; Blanchette & Campbell, 2012; Blanchette, Lindsay, et al., 2014; Eliades et al., 2012; Muris et al., 2003; Schwarz & Bless, 1991; Tricard et al., 2018).

Then, a dichotomous view between Type 1 and Type 2 seems problematic, since an unambiguous categorization into either type is contentious (Varga & Hamburger, 2014). For some researchers, the evidence support quantitative differences rather than qualitatively distinct processes (Osman, 2013) or the same mechanisms are used for both Type 1 and Type 2 (Colder, 2011). That's why, a continuous view is adopted (Kruglanski, 2013; Kruglanski & Gigerenzer, 2011). According to Evans and Stanovich (2013), the continuous view is adopted for the *modes* of processing but not for *types* of processing. Both modes and types are often confused. *Modes of processing,* also termed thinking dispositions, are defined as cognitive styles applied in Type 2 processing and authors write:

"For these reasons, we both have recently reverted to the older terminology of Type 1 and 2 processing. These terms indicate qualitatively distinct forms of processing but allow that multiple cognitive or neural systems may underlie them. We also believe it is essential to avoid confusion between dual types and dual modes of thinking (Table 2; see Evans, 2010a). Modes of processing are cognitive styles and are manifest within the domain of what we regard as Type 2 thinking. Unlike types, they typically represent two poles of a continuum of processing styles." (Evans & Stanovich, 2013).

Among the characteristics associated with each process, Evans and Stanovich considered that the distinction between Type 1 and Type 2 is based on access and use of working memory resources (Evans, 2008; Evans & Stanovich, 2013). Thus, Type 1 would not require working memory resources, whereas Type 2 would, leading to inter- and intra-individual differences depending on working memory capacities and cognitive load. The other characteristics listed in Table 2 are not considered

as defining and distinguishing characteristics of these processes, but as properties that have sometimes been found to be correlated or mistakenly associated with a process; for example, Type 2 is considered abstract because Type 1 reasoning is thought to be concrete. In addition, the characteristics associated with Type 1 (intuitive, heuristic) have long contributed to the idea that this process is irrational because they are always involved in errors of reasoning. Conversely, Type 2 was perceived as a "rational repairer" of errors committed by Type 1. However, research by Evans and Stanovich qualified this assertion by showing that the Type 1 process could lead to correct answers and that Type 2 could lead to bias in some circumstances (Evans, 2007; Stanovich, 2011). It seems that the ability to use Type 2 processes increases with age, although use of Type 1 remains predominant (Jacobs & Potenza, 1991; Klaczynski, 2001), which explains why children are sometimes more effective than adults in certain tasks. A study by Lucas, Bridgers, Griffiths, & Gopnik (2014) compared the abilities of 4/5-year-olds and adults to acquire new insights from information about causal relationships. The capacity of inductive reasoning is used. In a training events, participants observed experimenter placed objects with different shape (prospective cause), alone or by pairs, on a machine. In some cases the machine activated by lighting up and playing music (effects). After this training events, participants were asked to both judge the efficacy of the objects and to design actions to prevent an effect. This new knowledge concerned the ability to infer the link between an object and the triggering of a mechanism. The results indicate that children can learn a new correct causal relationship faster than adults (by the use of only a handful of events) and were more likely than adults to generalize an unusual conjunctive relationship, suggesting that they are less dependent on previous experience than adults.

To understand how these normative or non-normative responses appear, it is important to look at the relationships between Type 1 and Type 2 processes.

The Hypothetical Thinking Theory to Explain the Functioning of Reasoning

Two modes of operation are commonly described in the literature to explain the relationships between Type 1 and Type 2 processes: first, *parallel-competitive theories* (Sloman, 1996; Smith & DeCoster, 2000) considers that the two processes are activated during a task involving reasoning and that in the event of conflict, the final decision is based on a third mechanism, usually inhibition. Secondly,

the *default-interventionist theory* (Evans, 2007; Kahneman & Frederick, 2002; Stanovich, 2011) postulates the existence of a Type 1 process that would provide an initial intuitive response, which could be overridden by a Type 2 process. In the field of reasoning studies, this theory seems the most promising for understanding and predicting the performance of individuals.

Thus, following the tradition of dual-process theories, which all postulate the existence of two processing systems, default-interventionist theories have emerged to explain the relationships between them. They include the hypothetical thinking theory (Evans, 2006, 2007), which aims to explain the functioning of reasoning, decision-making and judgment. Evans argued that analytic processing corresponds to a hypothetical way of thinking, that is, "*thought that requires the imagination of possible states of the world*", which are "*epistemic mental models*" (Evans, 2007). These mental models encode propositional attitudes towards alternative situations, for example "I think that X" or "I have doubts about Y". Based on research on heuristic biases (non-normative responses produced by Type 1 process), which lead individuals to focus on seemingly relevant preconscious information, and on analytical biases (non-normative responses produced by Type 2 process), whereby individuals tend to maintain an argument without considering possible alternatives, Evans (2007) proposed three principles:

- The *singularity principle* postulates that only one hypothetical possibility can be considered at a time. There are two sources of this limitation: first, the limits of short-term memory, and secondly, the serial nature of reasoning.
- The *principle of relevance* postulates that the mental model evaluated as being the most relevant to the situation will be considered first.
- The *satisficing principle* postulates that a model will be retained if no reason is found to change it.

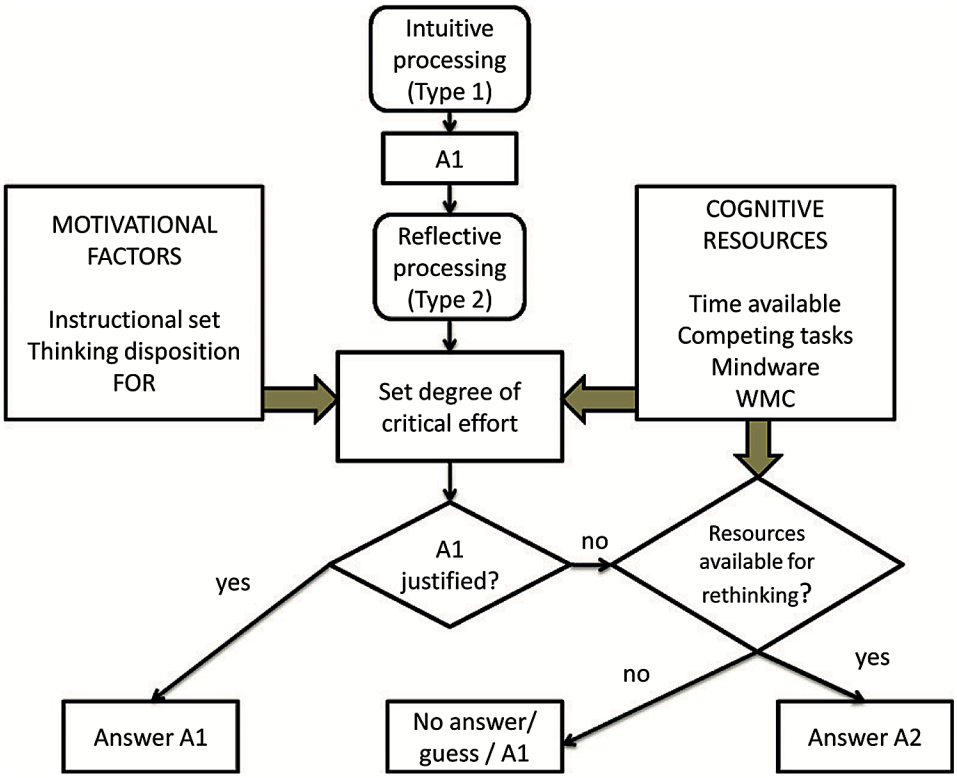
According to Evans (2007), these principles are the cause of two fundamental biases responsible for reasoning errors: the fundamental heuristic bias, i.e. the fact that "*people selectively focus on the information that is indicated as relevant*" (relevance principle), and the fundamental analytic bias, whereby "*people maintain the current mental model with an insufficient assessment and / or consideration of alternatives*" (principles of singularity and satisficing).

To understand why and how an intuitive response will be re-considered, Evans (2011) proposed a model to explain the link between the two processes, together with factors that influence their use. This model is known as the Intervention Model

(figure 3); it postulates that Type 1 processing will produce an intuitive response and that Type 2 processing may intervene, but sometimes only minimally, for example to make a response that is consistent with the instruction, but based solely on the intuitive or nonnormative response. That's why a nonnormative response can persist despite a Type 2 processing due to a lack of working memory resources or motivation. Thus, the use of the Type 2 process would be influenced by personal and task-related characteristics.

Thus, during a reasoning task, a Type 1 process will be activated automatically and will allow the production of an initial response that will take into account the purpose (evaluate a conclusion / produce a conclusion), the beliefs and knowledge of the individual, and some task characteristics (e.g., in a conditional reasoning task, to complete "*If P then Q, P therefore*?" participants will use the terms *P* and *Q*). For example, with the sentences "all flowers have petals / roses have petals / therefore roses are flowers", with prior knowledge of participants the initial response could be "Yes". This answer is false based on formal logic but true based on everyday logic In Evans' model, A1 is the initial, intuitive response that is suggested but not

Figure 3. The intervention model of evans (2011)



explicitly stated. After this initial response, a reflective process, corresponding to a Type 2 process, is activated. This enables participants to justify their answer - even if it's wrong, or change their answer if this is shown to be necessary by the evaluation that follows A1. Activation of this Type 2 process leads first to an assessment of the degree of effort than people would engage in this task, based on two types of factor:

- *Motivational factors,* arising from instructions that prompt a Type 2 process (Evans, Handley, Neilens, & Over, 2010); the cognitive dispositions of the individual (the Need for Cognition: Macpherson & Stanovich, 2007; Stanovich, 1999); and a feeling of confidence in the initial A1 response (Thompson, 2009).
- *Factors related to cognitive resources,* including the time available to perform the task (Evans & Curtis-Holmes, 2005; Macpherson & Stanovich, 2007) as time constraints hinder the use of Type 2 processes; dual-task situations that reduce working memory and limit the use or effectiveness of Type 2 processing (De Neys, 2006); general cognitive abilities (Kokis et al., 2002; Macpherson & Stanovich, 2007); the availability of relevant "mindware" (i.e. mental knowledge) to solve the task (Stanovich, 2011).

The next step in the model is to verify the initial intuitive response (A1). If no conflict is detected, this response will be accepted with a superficial Type 2 process. If a conflict is detected following the assessment of the degree of effort required, the probability that A1 will be accepted changes. If the level of effort that people accepted for the task is low, the individual will keep A1 to give a response. The Type 2 process will be used solely to justify the intuitive response (rationalization). However, if A1 is not satisfactory and the necessary cognitive resources can be activated to produce a new response (A2), Type 2 processing will be used to inhibit and override the intuitive response (decoupling).

While the hypothetical thinking theory proposed by Evans (2006, 2007) provides a model explaining both the performance of individuals and the type of processing engaged in a reasoning task, it does not include a process that Evans himself considered to be important, namely the **emotional process** (Evans, 2008). For example, in the area of moral judgment and blame, the presence of emotions during the deliberation process is assumed and considered too irrational to support justice. That's why, one of the standard instructions given by judges to members of the jury is that they should not allow any emotion, as sympathy, influence their judgements (Feigenson, 1997). The emotional process is thought to be related to Type 1 processing and is

explicitly associated with it in some dual-process theories (Epstein, 1994). Moreover, the brain regions typically associated with Type 1 processing are also those involved in emotional processing (Lieberman, 2003). Besides, many studies have found a strong link between emotional states and reasoning, at all ages (Amsterlaw, Lagattuta, & Meltzoff, 2009; Blanchette & Campbell, 2012; Blanchette, Lindsay, & Davies, 2014; Eliades, Mansell, Stewart, & Blanchette, 2012; Muris, Merckelbach, & van Spauwen, 2003; Schwarz & Bless, 1991). Finally, although emotions can lead to bias (De Martino, Kumaran, Seymour, & Dolan, 2006), they can also be an important aid in gaining access to deductive logic through the retrieval of emotional experience in memory, which can inhibit the intuitive response (Houdé & al., 2001).

WHAT IS THE ROLE OF THE EMOTIONAL PROCESS?

What Is an Emotion?

The difficulty of finding a consensus to define emotions is explained by their complexity in terms of both nature of emotions and form of their expression. Plutchik (1980) found more than 20 definitions of emotion in journals of psychology or psychiatry published between 1884 and 1977, and he found no consensus between them. He also observed that some authors proposed emotional theories without explicitly defining the concept of emotion. The number of definitions of this concept increased three-fold between 1971 and 1981, as Kleinginna and Kleinginna (1981) found 92 definitions depending on the aspect of emotion considered. Despite numerous disagreements, a consensus emerged in the 1990s that emotions are a rapid response of short duration to the perception of an event (internal or external), and are the consequence of modifications of at least three components: cognitive, behavioral and physiological (Watson & Clark, 1992).

Emotions are triggered by a particular event that is considered significant for the pursuit of the individual's goals and well-being. This may involve stimuli that are either external (e.g. natural phenomena, the behavior of others or animals) or internal (i.e. our perception of our own behavior, recalled or imagined mental representations of events). The consequence of this situation, which the individual sees as important, is an intense but short-lived, synchronized and appropriate response of the three components. Depending on the importance of the triggering event, the response concerns all or part of the emotional subsystems. The components of emotions are presented below.

- The **cognitive component** is also called subjective emotional experience or subjective feeling. The terms emotions and feelings have often been conflated, but in current theories, feelings are viewed as the part of emotion that corresponds to subjective and personal emotional feelings. It is the conscious aspect of the emotional process and, unlike the other two components that can be measured objectively, the subjective component is only accessible to the individual.
- The **physiological component** corresponds to changes in the level of physiological activation enabling the individual to react to the situation. These physiological manifestations may be related to either the central or the peripheral nervous system. The changes observed during an emotional experience may concern the endocrine system (hormone secretion rate), the autonomic nervous system (heart rate, blood pressure) and / or brain activations.
- The **behavioral component** is the motor expression of emotion. The goal of this component is to communicate reactions and intentions and it can involve facial, postural, gestural and vocal expressions. Behaviors are indicators of the tendency to act initiated by the emotional assessment of the situation.

Research on the Link Between Emotions and Reasoning

Lefford (1946) observed that reasoning tasks with an emotional content produce more errors than those with a neutral content. He concluded that emotions interfere with reasoning abilities. This observation has been supported by numerous studies (Blanchette, 2006; Blanchette & Richards, 2004; Melton, 1995; Palfai & Salovey, 1993), in which the emotion was either induced in the laboratory through different procedures or manipulated by the content of the reasoning task. For example, Blanchette and Richards (2004, Study 1) presented conditional deductive reasoning tasks based on the premise "*If P then Q*" using either emotional terms (e.g., "danger", "punishment" or "friendly") or words with neutral content (e.g., "sandwich", "bookstore" or "car"). For example: "If someone is in a tragic situation, she cries / Anne is in a tragic situation. Does she cry? / Yes or No". The authors found that adults' performance was worse when the content had an emotional value, and they concluded that emotional content impairs reasoning skills. Similar results are observed when the participants' emotional state is induced before the reasoning task, suggesting that there is a deleterious effect of positive or negative emotion on reasoning skills (Eliades, Mansell, & Blanchette, 2013; Eliades et al., 2012; Melton,

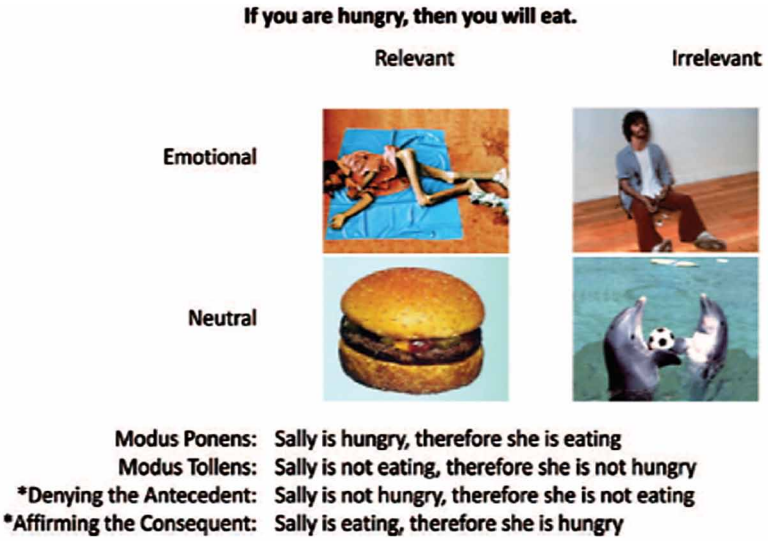
1995; Oaksford, Morris, Grainger, & Williams, 1996; Palfai & Salovey, 1993). Studies investigating the effect of emotions on reasoning have often examined only whether the response is normative or non-normative, but recent studies on reasoning also focus on the type of processing used to solve tasks. In line with dual-process theories, they examine two processes: Type 1, often related to the use of heuristic strategies, and Type 2, which is reflective. To date, few studies have investigated the relationship between emotions and the type of process used to perform a task. Eliades et al. (2013) examined the effect of emotion on statistical reasoning, using a base rates task, in which the content was neutral, emotional or related to sexual abuse. The inductive reasoning is used to answer this task. Participants are twenty-seven victims of sex abuse and one hundred and twenty-eight adults in the control group. They had to choose the most likely outcome of a situation based either on statistical information (the base rate) or on personal information (anecdotal). For example, "In a sample of 1,000 people, 995 are anorexic and 5 are in good health. Hugh is 25 years old, measures 1.82m and weighs 95kgs. Which is most likely: Hugh is anorexic / Hugh is in good health?". The authors found that participants mainly used anecdotal information, linked to a Type 1 "heuristic" process, when the content of the problem was emotional, to the detriment of the statistical information associated with a Type 2 "reflective" process. A similar observation was made for deductive reasoning by Eliades et al. (2012) with adults, victims or control, in an experiment involving a categorical syllogisms task with either emotional or neutral content. Emotional reasoning tasks produced more responses based on belief-bias than a neutral situation, indicating a decrease in the use of Type 2 processing ("reflective").

However, Goel and Vartanian (2011) did not find this effect with thirty-four undergraduate students although their tasks were similar to those used by Eliades et al. (2012). They found that participants made more accurate validity judgments about logical but unbelievable syllogisms with emotional content (e.g. All handicapped are capable) than about invalid but credible syllogisms without emotional content (e.g. No Catholic nuns are priests / Some women are Catholic nuns / No priests are women). Thus, negative emotions could mitigate the effect of belief-bias by fostering greater vigilance and a more systematic information processing style. An explanation can be found in studies and theories linking emotions and cognition. For example, the "feelings-as-information" approach (Schwarz & Clore, 1988) postulates that emotions, and affects in general, provide information about the situation and enable the individual to respond adaptively. According to this approach, positive emotions signal a benign situation, leading the individual to adopt prosocial behavior. By contrast, negative emotions warn the individual of a threat in their environment

and lead to avoidance behavior and information seeking. The theory of "mood as information" (Schwarz, 1990) postulates that when the situation is perceived as benign (based on affective information), individuals have little motivation to process the information in depth; such costly processing is not required because there is no risk that their needs will not be met. By contrast, in a negative emotional situation, individuals are more motivated to engage in cognitive efforts to process information. The use of more systematic information processing, corresponding to the Type 2 process ("reflective") described in dual-process theories (Evans, 2007), would be linked to the need to improve this negative emotional state by investing more resources to make the right decision (Isen & Geva, 1987; Isen, Nygren, & Ashby, 1988; Raghunathan & Corfman, 2004). More specifically, the mood and general knowledge model (Bless, 2000) suggests that it is not only the individual's motivation that is modified by the affective information provided by the situation, but also the type of processing used. Negative emotional states warn individuals that their needs may not be met and that they need to react accordingly. This change is facilitated by systematic, detail-oriented processing and low risk-taking, reducing the use of heuristic strategies to avoid adding new negative consequences and thus increasing negative affect. By contrast, positive affective states indicate that the situation is benign, so individuals invest fewer attentional resources in information-processing tasks unless they are required for the pursuit of a particular goal. In this situation, they make greater use of heuristic processes, involving simplified information processing rules. However, based on Evans' (2011) intervention model of reasoning, motivational factors play an essential role in the extent to which individuals use Type 2 processing ("reflective") for more in-depth task processing. When the response provided by Type 1 processing ("heuristic") is not rated as satisfactory, individuals who are strongly motivated to complete the task will produce and evaluate mental models, in order to find a response based on the application of logical rules.

Emotions are postulated to have an adaptive function (Plutchik, 1982), so it is surprising that their influence on reasoning has been widely observed to be deleterious. It seems that the link between emotion and reasoning is complex, as suggested by some researchers who have found that this effect can be reduced, or even reversed (Blanchette & Campbell, 2012; Blanchette & Caparos, 2013; Blanchette, Richards, Melnyk, & Lavda, 2007; Gangemi, Mancini, & Johnson-Laird, 2013). In four experiments, Blanchette, Gavigan, & Johnston (2014) demonstrated the moderating role of relevance on the impact of emotions on deductive reasoning. Thus, participants gave fewer normative responses when stimuli that were not semantically related to the content triggered a negative emotional response (figure 4). By contrast, when

Figure 4. Example of a conditional reasoning statement used in the experiment (Blanchette, Gavigan, et al., 2014) with the different inferences (indicates logical fallacies) and the four possible images representing the levels of the independent variables: relevance and emotion*



the negative emotional response was triggered by stimuli semantically related to the reasoning task, this effect was attenuated. It seems, then, that the relevance of the emotion for the current task modulates its influence on reasoning ability. When the emotion is relevant to the task at hand, processing the emotional stimuli improves performance. On the other hand, if the emotion is not relevant to the task, the attentional resources deployed to process the emotional stimuli will interfere with the task and impair performance (Blanchette & Campbell, 2012; Blanchette & Caparos, 2013; Blanchette, Gavigan, et al., 2014; Blanchette & Richards, 2010; Blanchette et al., 2007). This observation of the relevance of emotion has led researchers to propose a distinction between incidental and integral emotions (Blanchette, Gavigan, & Johnston, 2014). To explain the findings of the influence of emotions on reasoning, some authors focus on the mechanisms involved in reasoning and the influence of emotions on these mechanisms (Blanchette, Caparos, & Trémolière, 2017). Due to the different influence of these two kinds of emotion on reasoning, both incidental and integral emotions will be distinguished in the next section.

Mechanisms Used to Explain the Link Between Emotions and Reasoning

Blanchette, Caparos and Trémolière (2017) divided the mechanisms underlying the effects of emotion on reasoning into three categories, corresponding to the three components of emotion: cognitive, physiological and behavioral. Although studies have generally focused on the cognitive component, the mechanisms for the three components will be presented briefly (for more details see Blanchette et al., 2017, p. 62-65).

Cognitive Mechanisms

The deleterious effect of incidental emotions on reasoning is often attributed to the cognitive load induced by the treatment of emotional information, which are irrelevant for the current task (Blanchette, 2006; Blanchette & Richards, 2004; Oaksford et al., 1996). Indeed, reasoning tasks using Type 2 processing to produce a normative response require a larger working memory load than tasks that can be solved by Type 1 processing, which requires few cognitive resources (De Neys, 2006). However, it seems that emotion, when it is irrelevant to the current task, activates mental representations in memory that hinder Type 2 processing. This hypothesis is supported by studies on incidental emotions and reasoning that found a deleterious effect of emotion, and also by research on integral emotions. When the emotion is relevant to the task, concepts that are necessary to solve the task are activated, improving performance.

Another hypothesis concerns the individual's motivation and commitment to the task, modulated by its relevance. Thus, when the task is seen as relevant, emotion focuses the individual's attention and commitment on the task. In the opposite situation, motivation would be lower, which would explain the use of less costly processing. Motivation plays an important role in the intervention model (Evans, 2011), because it determines the level of commitment that the individual invests in Type 2 processing.

Physiological Mechanisms

A series of studies conducted by Blanchette and Leese (2011) demonstrated physiological arousal when participants were presented with negative stimuli. Inducing negative emotions increased skin conductance and was associated with

logical errors in deductive reasoning tasks. Physiological arousal has also been measured using pupil dilation (Prehn, Heekeren, & van der Meer, 2011). In that study, participants were asked to assess pairs of words based on two criteria: their conceptual relationship (e.g., boat and port) and their emotional relationship (e.g., tumor and brain). The results indicate that pupil dilation was greatest when the pairs were related both conceptually and emotionally. Processing conceptually congruent words with negative valence increased pupil dilation and also produced a higher error rate and slower processing speed than neutral or positive word pairs. The authors concluded that processing dissimilar pairs is rapid and automatic, and that the increase in pupil dilation reflects an increase in the attentional resources allocated to the task. They postulated that negative valence items are more costly to process than positive valence items because of their emotional significance.

The precise functioning of physiological mechanisms on reasoning has yet to be researched, but Blanchette et al. (2017) suggested avenues for research related to brain function. For example, there is evidence that the prefrontal ventromedial cortex is involved in heuristic processing and emotional reasoning (Nicolle & Goel, 2014). It is possible that incidental emotions are triggered by activation of the prefrontal ventromedial cortex, increasing the use of heuristic processing and thus the number of non-normative responses observed in deductive reasoning tasks with irrelevant emotional content.

Behavioral Mechanisms

Very few studies have been conducted in relation to behavioral mechanisms and reasoning performance. Only one study (Blanchette & Amato, 2013) sheds some light on the issue. The authors found that inducing negative-valence facial emotions increased the deleterious effect of emotions on reasoning. They postulated that this is due to the use of behavioral information to determine emotional feeling; here, the negative facial expression increased the negative emotional feeling, which in turn increased the effect of emotion on reasoning.

CONCLUSION

Studies on reasoning suggest several ways of understanding the widely observed differences in performance. First, the argumentative theory of reasoning (Mercier & Sperber, 2011) raises questions about the communicative function of reasoning

at the individual level. Indeed, if the function of reasoning is to justify or evaluate an argument for others, what conclusions can researcher draws from tasks carried out individually? Does reasoning function the same way in individual and collective situations? Secondly, Evans' (2011) intervention model highlights the importance of motivational factors to explain why individuals engage in more cognitively demanding processing. The role of motivation in the link between emotion and reasoning seems to offer a promising explanation of inter- and intra-individual variations in cognitive processing. Moreover, in the most recent development of the dual process theories, the influence of cognitive control is underline and a Type 3 process is added (Evans, 2009, 2019; Houdé, 2019). Type 3 processes defined by Evans (2009, 2019) is a monitoring and control processes used, for example, for setting the degree of critical effort, or deciding whether to engage new reasoning when the default intuition is unsatisfactory. This term is similar by the one proposed by Houdé (2019), the inhibitory-control system. Houdé (2019) argues that the brain used a third control system located in the prefrontal cortex. This system is dedicated to inhibiting intuitive heuristics system (Type 1) and activating logical algorithms system (Type 2) depending on the goal and context of the task. He developed a *3-System Theory of the Cognitive Brain* which explains the early logical abilities discovered in babies, the non-linear process of cognitive development in children, and the fast heuristics and biases observed in adults. In the area of moral judgement, as emphasized by Helion and Pizarro (2015), if the division of the mind in two systems lead some researchers to consider emotion and reason acting in opposing direction, recent studies highlight a more complex interaction between these two processes to motivate judgment and action (Pizarro, 2000). However, current dual process theory does not include emotion in the reasoning process and does not take into account the regulation strategies individuals employ in everyday life to reasoning. These area of research since important to consider in order to better understand the complex process implied to reason. In a societal consideration, better understanding of the links between emotion and reasoning could lead to interesting applications in the field of education. For example, to propose facilities which promote school learning. Indeed, to enable the child to make the best use of his or her skills, it seems important to propose an environment that promotes positive emotions (Tricard & al., 2018). It could be through the material (use of playful material) and pedagogical positioning (using the encouragement of progress points) when we solicit them to work on logic problems. Works on the recognition and management of emotional states could also be beneficial. Finally, it seems important to take an interest in the emotions of students with difficulties in school to see in a situation of dropping out in order to share what falls within their skills and what falls within the emotional situation they are living.

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KEY TERMS AND DEFINITIONS

Argumentative Theory of Reasoning: this theory is developed by Mercier and Sperber (2011) and postulates that the function of reasoning is not to discover a rational truth but rather to find arguments supporting our point of view or decision in order to convince others, and to evaluate and filter information we receive when someone tries to convince us.

Deductive Reasoning: using knowledge of the premises, to draw firm conclusions about a given situation.

Dual Process Theory: theoretical framework which posits that two types of cognitive processes can explain the reasoning patterns.

Emotion: a rapid and strong response of short duration to the perception of an event (internal or external) as important for goal and activity, accompanied by behavioral, physiological and cognitive changes.

Incidental Emotion: affective reaction irrelevant to the contents reasoned about.

Inductive Reasoning: generalizing observations or concrete cases to establish a general rule that is relevant in other similar cases.

Integral Emotion: affective reaction relevant to the contents reasoned about.

Reasoning: the ability to draw a conclusion from elements of the situation that are already knows, the premises.

ENDNOTE

[1] Our translation

Chapter 4
Morality and Contemporary Civilization:
A Dual Process Approach

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ABSTRACT

This chapter investigates if System 2 (analytic system) can revise or suppress the negative outputs of System 1 (intuitive system) by natural experiment in history. Two periods are picked up in this chapter: the 17th century when there was a decline in war, torture, cruel punishment, and religious persecution, and the time after World War II when there has been a decline in war, genocide, and violence with growing awareness of human rights. In short, the outputs associated with strong emotion are less likely to be revised, and an effective way for revision is to use a story to trigger the theory of mind in System 1. This is also discussed in the frame of distinction between deontic moral judgment and utilitarian moral judgment. Finally, it is proposed that a good story should be elaborated by System 2 and be prevailed so that it arises emotions (sympathy) of System 1 and drives people for the better-being future.

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INTRODUCTION

It is commonly claimed that morals and ethics have been lost in contemporary civilization. As we become increasingly competitive in this industrial society, we are less likely to experience sympathy and exhibit warmth toward others. An influential idea in this regard stems from the notion of the "noble savage," originally proposed by Jean-Jacques Rousseau. According to this concept, people in hunter-gatherer societies were nonviolent in nature, and immoral, aggressive behaviors have been acquired in the course of the development of civilization in general and weaponry in specific. This notion was empirically supported by Mead's (1935) reports about the primitive people in Samoa.

However, the empirical basis of Mead's take on the "noble savage" was seriously criticized by Freeman (1983). He pointed out many defects in Mead's anthropological research in Samoa: Mead did not speak the Samoan language and her perspective was skewed by her belief that this primitive society could be compared to Eden. The "facts," as understood by Mead, were not verified by follow-up studies in Samoa. Daly and Wilson (1988), who attempted to analyze who commits murder, under what circumstances, and for what purposes from the perspective of human evolution, demonstrated a decrease in the number of murders from the time of hunter-gatherers to the contemporary world. For example, in industrial countries, there are about 10 murders per million people in a year. However, there were about 300 among the San of the Kalahari, known as the least aggressive of the hunter-gatherers. The concept of the "noble savage," therefore, is just a nostalgic myth. Furthermore, according to Pinker (2011), people today are less violent (fewer murders and wars and less cruel punishments) than those in the past.

As morality is culturally relative, it is difficult to make a comprehensive judgment regarding which cultures or in which times people are more moral. However, we can identify some markers of immorality: murder, violence, fraud, discrimination, and so on. Pinker (2011) points out that wars decreased concurrently with the decline in discrimination after World War II. These trends are observed in most parts of the world, including Japan. According to statistical data, the number of crimes, including murder, violence, and theft, has decreased since World War II. While this can be partially attributed to the development of scientific criminal investigation, it is also likely that public education has made people more familiar with moral values.

In this chapter, I discuss these social changes in terms of dual process theory. Dual process theorists posit that human thinking involves two kinds of mental processing: System 1, which is generally reliable but can lead to fallacies and biases,

and System 2, which can, at its best, allow human reasoning to follow normative rules. The former is an evolutionarily old heuristic system (intuitive mind) and the latter is an evolutionarily recent analytic system (analytical mind). As shown in Table 1, System 1 supports processing that is implicit, automatic, fast, intuitive, contextual, and associative, whereas System 2 supports processing that is explicit, controlled, slow, reflective, abstract, and rule-based.

The development of civilization can be viewed as the history of how System 2 has controlled the output of System 2. The history of civilization is no less the history of an increase of the availability of the cognitive capacity than human intellectualization is the growing process of the cognitive capacity of the evolutionarily recent heuristic system. In the next section, I will dwell on dual process theory.

DUAL PROCESS THEORY: REBELLION, COEXISTENCE, OR SERVITUDE?

Several dual process theories have been proposed over the past three decades ((Evans, 2010; Evans, & Over, 1996; Stanovich, 2009)). One of the most influential has been Evans and Over's (1996) distinction between implicit processes, which need fewer cognitive resources, and explicit processes, which are supported by cognitive capacity, which are then connected to two kinds of rationality: personal and normative. The

Table 1. Features attributed to the two systems of cognition

System 1	System 2
Evolutionarily old	Evolutionarily recent
Unconscious, preconscious	Conscious
Implicit knowledge	Explicit knowledge
Automatic	Controlled
Fast	Slow
Parallel	Sequential
Low-capacity demand	High-capacity demand
Intuitive	Reflective
Contextualized	Abstract
Domain-specific	Domain-general
Associative	Rule-based
Connected to simple emotion	Connected to complex emotion
Independent of general intelligence	Linked to general intelligence

former is regarded as rationality in the wild environments where the human brain has been shaped. Hence, it is alternately called evolutionary rationality or adaptive rationality (Anderson, 1990). The latter is regarded as rationality in civilized society, where we are unable to establish definitive norms; logic, the theory of probability, and mathematics may be viewed as norms in logical and scientific thinking, but we do not apply absolute norms to everyday behaviors.

Their first motivation for proposing a dual process theory was to resolve the paradox of humans demonstrating great intelligence in the establishment of contemporary civilization, including logic, sciences, political and economic systems, and technologies, and yet being susceptible to many kinds of biases, often making errors when solving psychological tasks (Evans & Over, 1996). This presupposes that the contemporary development of the sciences and civilization is a product of System 2. The reason why human thinking or reasoning is sometimes flawed is that the processing of System 1 begins more quickly than that of System 2, causing cognitive bias.

Then, can System 2 completely control the output of System 1? Evans (2007) proposed three kinds of possible models for the relation between Systems 1 and 2. The first is the pre-emptive conflict resolution model, which assumes that a decision is made at the outset as to whether a System 1 or System 2 process will control the response. The second is the parallel-competitive model, which assumes that each system works in parallel to produce a putative response, sometimes resulting in conflict that needs to be resolved. The third is the default-interventionist model, which involves the cueing of default responses by System 1 that may or may not be altered by subsequent interventions of System 2. The second and third models are the most feasible in everyday scenarios.

In order to apply the framework of dual process theory to the development of contemporary civilization, I consider three scenarios. The first is to suppose that System 1 can revise the output of System 2 based on the default-interventionist model. The second is to suppose that the outputs of System 1 and System 2 coexist. This idea is based on the parallel-competitive model, but it does not suppose any perfect resolutions of the conflict between the two systems. The third is to suppose that System 2 exists only to provide a rationale for the output of System 1. It is also based on the parallel-competitive model but assumes that System 2 is just a servant of System 1.

Dual process theorists were optimistic in assuming that the output of System 1 can be revised by System 2 at first (e.g., Evans & Over, 1996). For example, although people are very likely to make an error in solving many kinds of cognitive tasks, when

they are given the correct answer, they can understand that it is normative with the help of System 2 (e.g., Wason, 1966). In other words, the error is made intuitively by System 1 but can be corrected by System 2. However, apart from cognitive tasks, revisions are not always positive. As System 1, which is an evolutionarily old heuristic system, serves genetic interests, revision by System 2, which is the evolutionarily recent analytic system, can be a rebellion in this sense. A typical and literal rebellion is suicide, which goes completely against genetic interests. Human beings are the only creatures who commit suicide. While the influencing factors of suicide are generally mental disorders such as depression, long-term perspective supported by the high cognitive capacity of System 2 can also be a contributing factor. System 2, which affords a long-term perspective, makes it possible for human beings to recognize their mortality. Although a long-term perspective helps people solve complex problems such as those related to their careers, it sometimes makes them lose all hope for their future.

There are several examples for the second case: coexistence. For instance, although we swallow our saliva automatically and unconsciously, the idea of spitting it out into a cup and drinking it is repulsive. System 2 tells us that the saliva in the cup is identical to what we naturally swallow. However, we are repulsed by other people's saliva, and our own saliva, once it has left our mouths, is automatically associated with that of others. The fear of saliva, which is very similar to the fear of blood, is caused with the trigger of hazard management (Fiddick, Cosmides, & Tooby, 2000). Hazard management is assumed to be a unit or module of System 1. It responds to stimuli domain-specifically that potentially give harm to us, evoking disgust and fear. Saliva is included in this domain. Generally, as shown in Table 1, the output of System 1 entails a single emotion such as fear, and this emotion is less likely to be revised or suppressed by System 2. Therefore, even if the rational thinking by System 2 guarantees that the saliva in a glass is not hazardous, the output of System 1 (the hazard management) is too strong to be suppressed by System 2. In short, the outputs from System 1 and System 2 coexist in our minds. Another example is the Japanese superstitious belief in Butsumetsu, one of the six days in the lunar calendar, which literally means "Buddha's death." The Japanese consider it the unluckiest day, and thus avoid having a wedding ceremony on the day. Although System 2 tells the Japanese that this belief is irrational, it is plausible that a fear based on the superstition (from System 1) is not completely suppressed. In other words, the thought that superstitious beliefs regarding Butsumetsu are irrational and the fear of sabotaging their married life may coexist in a couple's minds. Generally, when the output of System 1 is accompanied by an emotional response, it is unlikely to be suppressed by System 2.

The third is that the function of System 2 is just to rationalize the output of System 1. Haidt (2012) demonstrated that not only is intuitive moral judgment unlikely to be suppressed but also that System 2 is used just to rationalize intuition. In that study, participants were presented with the following vignette.

Julie and Mark are siblings. They are traveling together in France on summer vacation from college. One night, they are staying alone in a cabin near the beach. They decide that it would be interesting to try making love. At the very least, it would be a new experience for each of them. Julie is already taking birth control pills, but Mark uses a condom too, just to be safe. They both enjoy making love but decide never to do it again. They keep that night a special secret, which makes them feel even closer to each other.

Many of their participants gave a negative evaluation of Julie and Mark's behavior. The reasons why they were negative were just for the justification of their evaluation. Their intuitive evaluation came from System 1. System 2 did not revise this intuitive judgment, but gave reasons to justify it. For example, although they knew that the probability of pregnancy was very low, participants considered the possible genetic defects of inbreeding.

SOCIAL DEVELOPMENT AND THE DECLINE IN WAR AND VIOLENCE

I apply these three possibilities to the explanation of historical development. As mentioned in the Introduction, in this modern world, humans have achieved the most peaceful society in history. Although the output of System 1 with strong emotions is unlikely to be revised or suppressed by System 2, System 2 has historically had a certain measure of success in taming System 1. This is not restricted to direct control; the establishment of legal systems and social customs has ensured the inhibition of violent and ego-centric behaviors and the encouragement of moral and prosocial behaviors.

In this chapter, I focus on two major periods as put forth by Pinker (2011). The first is the 17th century, when there was a decline in war, torture, cruel punishment, and religious persecution (including witch trials). According to Pinker (2011), two possible factors were influential in these changes. The first was the establishment of absolute monarchy. It worked as a "Leviathan" to suppress civil wars and conflicts

between feudal lords in France and Germany (Holy Roman Empire). The Thirty Years' War, in which many European countries were involved, ended in 1648 in Germany. The early phase of this war can be viewed as a religious conflict between Catholics and Protestants, but the weight of religious conflict reduced and the continuation of the war appeared as the Bourbon (France)-Habsburg (Austria) rivalry for European political pre-eminence. Through the war, each of the Imperial governments became more centralized, and it worked as a "Leviathan." In other words, each monarchy controlled local feudal lords like a police force.

The second factor pointed out by Pinker (2011) was the prevalence of novels. After first being used for the publication of the Bible, in the 16th century, Johannes Gutenberg's invention, the printing press, began to be used to publish novels. The Frenchman Jean de La Fontaine, who was the most widely read poet of the 17th century, wrote many fables inspired by *Aesop's Fables*. His fables were popular and provided a model for subsequent fabulists across Europe and numerous alternative versions in French and France's regional languages. The full-scale development of the novel started in 18th century England, when Daniel Defoe wrote *Robinson Crusoe* and Jonathan Swift wrote *Gulliver's Travels*. *The Sorrows of Young Werther* (*Die Leiden des jungen Werthers*) by Johann Wolfgang von Goethe was also published in Germany around this time.

The effect of the second factor can be interpreted in the framework of dual process theory. Particularly, it is plausible that mindreading was facilitated by reading, which also increased sympathy for the victims of war, torture, and cruel punishment. Mindreading is based on the theory of mind (ToM) subsystem of System 1 (Baron-Cohen, 1995; Leslie, 1992). ToM makes it possible to construct a theory to explain others' behaviors. In other words, people can understand the motives for a specific behavior displayed by someone else, assuming that the actor has a human mind. Like with other subsystems of System 1 (see Table 1), ToM processing is automatic, domain-specific, and connected to simple emotion. The ToM subsystem works automatically in the context of specifically human actions, and is accompanied by emotional responses. It was developed to help humans understand each other and maintain social relationships.

However, the ToM subsystem actually works with the cognitive capacity of System 2 in the real world (e.g., Carlson, Moses, & Claxton, 2004). The executive function of System 2 helps the ToM work adaptively in this contemporary world. ToM's actual domain of concern is human behaviors. However, with the support of System 2, its purview has broadened to include the behaviors of animals and fictional characters. When one reads a novel, he or she usually simulates what its

protagonist thinks, understands his or her emotions, and sympathizes. If a hero dies hopelessly, the reader feels pity for him. Through the practice of reading, people began to understand the grief, agony, pain, and sting of death of victims of war, violence, and torture, and to feel sympathy for them. It is very likely that this sympathy could have had the power to stop war, murder, violence, and torture in the 17th and 18th centuries in Europe.

The novel was influential in putting an end to an inhumane legal institution in America, too. *Uncle Tom's Cabin*, an anti-slavery novel by Harriet Beecher Stowe, was the best-selling novel of the 19th century. It tells the story of a slave, Uncle Tom, and many people experienced the misery of slaves when they read it. Hence, it is credited with helping fuel the abolitionist movement in the 1850s. Abraham Lincoln met Stowe at the start of the Civil War, and said, "So this is the little lady who started this Great War." This novel had the power to abolish slavery in America.

The second era of interest is the time after World War II. This period is characterized as no great war after 1945 and no war and no genocide (there is a possibility that South Sudan violence is genocide) in the 21st century. It is also characterized as a time of a decline in murder and violence in many countries. Furthermore, there has been a growing awareness of human rights over the past 50 years, and this has included a decline in the prejudice and discrimination against people of color, females, and minorities. This has been unprecedented to the extent that even when the Civil Rights Act of 1964 to outlaw discrimination based on race, color, religion, sex, or national origin was enacted after the American civil rights movement, nobody could have predicted that in 45 years, an African American would be elected president. There has also been a decline in sexism owing to feminism. For example, the university-going rate of Japanese, which was 35 percent for men and 10 percent for women in 1970, increased to 56 percent for men and 48 percent for women in 2016. Fifty years ago, the common mindset in Japan was that women did not require higher education. However, over the past two decades, this belief has been gradually weakening.

The trends listed above are positive. However, they can be accompanied by negative consequences as a strategy of the weak. For example, there is an increase in the number of "difficult" patients, who break out into violent language and make unreasonable demands of doctors when things do not go their way. In Japan, they are known as "monster patients." Traditionally, patients have been in a weak position while doctors and hospitals have been in a strong position. Therefore, patients usually follow the advice of their doctors. However, with democracy came the idea that patients and doctors are equal; this, together with a skewed understanding of human rights, led to the creation of these "monster patients." This is also the case with some

parents in Japan. Parents usually follow the advice of their children's teachers, and thus are in a relatively weak position. However, there are some "monster parents," who are overprotective and make selfish requests and complaints to teachers. These two examples reflect trends associated with how those who have traditionally been weak can act and assert themselves when released from the restrictions associated with their position.

There may be specific factors responsible for each of the changes that took place after World War II. Concerning the decline in war, for example, with globalization has come an extraordinary growth in international trade, causing economic interdependence among countries. It is more beneficial for a country to trade with neighbor countries than to be engaged in war with them. Even if a country wins a war, it loses the benefits of trade. In short, international economic activity has changed from a zero-sum game to a non-zero-sum game. Democratic countries have built win-win economic relationships over the past half century. As for the decline in murder, the development of criminal investigation from a scientific standpoint can be a deterrent. Owing to the increased probability of being arrested and sentenced, murder has become a relatively ineffective conflict resolution strategy.

The most important factor underlying the trends after World War II is the spread of education. Public education systems across the world are teaching increasing numbers of students about the concepts of democracy, equality, and rational thinking. With the great surge in publication culture around the world, books, including novels, have become increasingly popular. It is very likely that the cultural practice of reading has enhanced people's mindreading of those who are in a weak position, similar to what occurred in the 17th century, thus sympathetic. The spread of education may have caused the Flynn effect: the substantial and long-sustained increase in both fluid and crystallized intelligence test scores that were measured in many parts of the world over the 20th century (Flynn, 2012). As these kinds of intelligence are more strongly under the restraint of the cognitive capacity of System 2 than academic abilities are, the scores were not thought to be changeable. The Flynn effect is regarded not as reflecting the growth of the cognitive capacity, but as the increased availability of this capacity in System 2. In other words, this effect cannot be attributed to the improvement of hardware (the brain) but to the increase in software efficiency. However, it is worthwhile to know that some researchers have reported a negative Flynn effect in Europe (e.g., Dutton & Lynn, 2014). Not only did the increase in test scores reach a ceiling but there was a slight decrease in these scores in some countries. The reasons for this decrease are thought to be the increase in the number of non-European immigrants who have not received higher education and the presence of dysgenic fertility. In any case, it is plausible that the cognitive capacity of System 2 has reached a plateau in the context of the present educational systems.

A DUAL PROCESS APPROACH TO HISTORICAL CHANGES: NATURAL EXPERIMENTS IN HISTORY

Control by System 2?

In applying the dual process theory framework, we need to recognize the difference between changes within an individual and changes in history. Knowledge, skills, and cultural values are passed down from one generation to the next. Therefore, an individual in later generations need not start from the very beginning; the computer has already been invented, legal systems are in place, and moral standards and norms have been established. Therefore, it is easier for System 2 to control the negative output of System 1 supported by these social, cultural, and scientific developments than it used to be.

Can we interpret the decline in war, violence, and murder and the enhancement of morality in terms of the revision of the negative output of System 1 by System 2? Consider the concurrence of the Flynn effect, the growing awareness of human rights, and the decline of murder and violence; is it possible that the latter two are attributed to the increased availability of this capacity in System 2 (the Flynn effect)? Although Stanovich and West (1998) have posited that the higher the IQ, the less biased a person's thinking, it is still uncertain if System 2 has more strongly controlled the negative output of System 1 since World War II. It is also possible that the spread of higher education caused social changes and the Flynn effect after World War II.

Generally, the emotional output of System 1 is not as easily revised or suppressed as cognitive outputs. It is obvious that System 2 has led to the revision of superstitious beliefs through the accumulation of scientific knowledge. Fewer and fewer people now believe in ghosts. However, as mentioned, even if System 2 allows us to reach the conclusion that superstitious beliefs are irrational, we still fear to break a superstitious taboo. In short, outcomes of System 1 coexist with those of System 2. This trend will probably continue for the moment. However, it is expected that in the future, even System 2 will identify superstitious beliefs as irrational.

If the practice of reading was responsible for people developing an aversion to cruelty, including murder, violence, and torture, in the 17th century (Pinker, 2011), in which category is this case placed: rebellion, coexistence, or servitude? It may correspond to rebellion, but not perfectly. As mentioned, the ToM subsystem is assumed to belong to System 1, but mindreading based on this subsystem has come to work beyond modularity with the aid of the executive function of System

2 (Carlson et al., 2004). For example, mindreading responds not only to a human action but also to the behavior of fictional characters, and lets us consciously simulate affective changes in the character. Hence, this case may be regarded as rebellion, but the biggest momentum for the changes in the 17th century was the affective and emotional force caused by sympathy for victims. This force is connected to System 1.

It is also possible that the negative output of System 1 has been getting weaker. I do not reject this possibility. However, more plausible reasons for the historical changes are the controls by System 2 using positive output (e.g., sympathy) of System, as discussed in the next section.

A Single Death Is a Tragedy, a Million Deaths Is a Statistic

Generally, the greatest changes in history have been caused and maintained by shared emotions. Emotions usually occur because of System 1 processes. If these cannot be controlled by System 2, they are likely to have negative consequences such as genocide. Furthermore, System 2 sometimes becomes a servant of System 1 just to rationalize its output (Haidt, 2012). For example, there were many people who hated pagans before the Enlightenment in 17th century Europe. Their hatred was based just on an intuitive feeling belonging to System 1 that pagans were strange. When System 2 was just a servant of System 1, it enforced this hatred by adding some prejudiced beliefs regarding the "evil" nature of pagans. However, emotions can also empower people to make changes for the better, as was the case in the 17th century. In this sense, they are a double-edged sword.

This is, in short, expressed in the words "A single death is a tragedy; a million deaths is a statistic." Although these words are sometimes attributed to Joseph Stalin, they are thought to be by Erich Remarque, the author of *All Quiet on the Western Front*, or Adolf Eichmann, one of the major organizers of the Holocaust and who was executed in Israel. This message can be interpreted in the following manner: while we can understand the story of a single death, we cannot follow all the stories of many deaths. There are about 3,500 daily deaths in Japan. However, we do not feel deep sorrow at each of them, unless the deceased is someone familiar. They are just recognized in the framework of statistics.

This is also called the "identifiable victim effect." Kogut and Ritov (2005) reported that their participants displayed greater willingness to help identifiable victims, such as those whose identifying information (e.g., a picture) was available. Their participants' emotional reaction to the victim got stronger when the victim was identified. Although they did not use the terms "mindreading" or "ToM," it is likely that the emotion arose in the process of mindreading, which is easier when identifying information is available. Emotion, as previously mentioned, is a product of System 1.

The identifiable victim effect is often evident in the real world. For example, in 1987, Jessica McClure fell into a well at the age of 18 months. Rescuers tried to free her from the eight-inch well, but her rescue was much more difficult than initially anticipated. From beginning to end, this rescue effort was given live media coverage. As a consequence, viewers donated over 700,000 dollars to the rescue effort. This sum could have helped save many malnourished infants in poor countries. In reality, despite UNICEF's efforts to gather donations for these infants, such a large sum is difficult to manage. However, in Jessica McClure's case, this was achieved because for many of the people, she corresponded to a single tragedy, whereas many poor infants were just a statistic. In the framework of dual process theory, the emotional reaction in the former case arises in the mindreading process of System 1. However, even if System 2 judges that it is moral to donate to UNICEF, people are unlikely to do so unless their judgment is accompanied by emotional sympathy.

Another case was in Japan. *Crying out Love in the Center of the World* is a 2004 Japanese drama film based on the novel *Socrates in Love* by Kyoichi Katayama. This is a love story, in which the heroine dies of leukemia. After the film's release, the Japan Marrow Donor Program saw an increase in registrations for a few years. The Japanese government and Red Cross Society have made continuous efforts to encourage people to register as donors. However, this had little effect until the release of the movie. In other words, although people know that a bone marrow transplant is a treatment strategy for leukemia and lymphoma and are aware of the necessity of donors, they are not very likely to take the first step of registration. However, the film/novel telling this tragic story aroused sympathy arose for the poor heroine, and they acted upon it by registering. This demonstrates that although System 2 tells people that registration is rational, ethical, and important, this judgment does not lead to action, which only comes from the emotional sympathy for the identified victim that is a product of System 1.

MORALITY AND TWO KINDS OF NORMS: DEONTOLOGY AND UTILITARIANISM

A classification of moral judgment very similar to that of processing in the context of dual process theory has been proposed: deontology versus utilitarianism. Table 2 shows the contrast between the two. Deontology is the normative ethical theory that the morality of an action should be based on whether that action itself is right or wrong under a series of rules, rather than the consequences of the action. It is

Table 2. The contrast between deontology and utilitarianism

Deontology	Utilitarianism
Kantian	Benthamian
Motivationalism	Consequentialism
Stronger in the footbridge problem	Stronger in the trolley problem
Intuitive inference	Utility calculation
Strong emotion	Weak emotion
Strong impulsion of act	Weak impulsion of act
VM-PFC	DL-PFC
System 1	System 2

Note: VM-PFC: Ventromedial prefrontal cortex, DL-PFC: Dorsolateral prefrontal cortex

described as "duty" or "obligation." This was posited by Immanuel Kant, who argued that each individual must act purely out of a sense of duty, and who began with the argument that the highest good must be both good in itself and good without qualification. According to him, the motivation for an action must be based on obligation and be well thought out before the action takes place.

The deontic judgment is contracted with the utilitarian judgment. Utilitarianism is an ethical and philosophical theory stating that the best action is the one that maximizes utility. In general, utility refers to subjective benefit, but in the context of ethics, it is defined as that which produces the greatest well-being for the greatest number of people. Jeremy Bentham, the founder of utilitarianism, described utility as the sum of all pleasure that results from an action, minus the suffering of anyone involved in the action. Utilitarianism is a version of consequentialism in this sense, which is contrasted with Kantian motivationalism. However, unlike other forms of consequentialism, such as egoism and altruism, utilitarianism considers the interests of all beings equally.

This contrast is very well illustrated in the trolley dilemma (Thompson, 1985). The general form of this problem is as follows.

There is a runaway trolley moving toward five tied-up people lying on the tracks. You are standing next to a lever that controls a switch. If you pull the lever, the trolley will be redirected onto a side track; thus the five people on the main track will be saved. But, there is a single person lying on the side track. Do you pull the lever to save the five people?

Many people respond affirmatively to this question. According to classical utilitarianism, this decision is not only permissible but, morally speaking, the better option, because sacrificing one life leads to saving five others. Therefore, this judgment and action conform well to utilitarianism, because this maximizes utility.

However, some do not respond affirmatively. They take an alternate viewpoint that moving to another track constitutes participation in a moral wrong, making one partially responsible for a death when otherwise no one would be responsible. This is because the action of pulling the lever kills a bystander who has done nothing to deserve it. Not committing murder is the golden rule; it can be found in sacred books such as the Bible. Therefore, pulling the lever is against this rule, and deontic judgment tells us not to do it because this action can be viewed as murdering the person lying on the side track.

This deontic judgment not to pull the lever can also take a different form: the footbridge problem. In this scenario, you are standing on a footbridge on the trolley track. There is a very fat man next to you, and if you push him over the bridge on to the track, he will die, but the five people can be saved. You are asked whether or not you would push him over the bridge. Many people respond negatively because they are likely to make a deontic judgment in this form of the problem.

There are three possibilities (Cushman, Young, & Hauser, 2006).

1. The action principle: Harm caused by action is morally worse than equivalent harm caused by omission.
2. The intention principle: Harm intended as the means to a goal is morally worse than equivalent harm foreseen as the side effect of a goal.
3. The contact principle: Using physical contact to cause harm to a victim is morally worse than causing equivalent harm to a victim without using physical contact.

The first is known as omission bias, and is also discussed in philosophical ethics. Generally, omission bias is the preference for harm caused by omissions over equal or lesser harm caused by intentional acts. Therefore, people judge that it is greatly immoral to take an action to pull the lever in the trolley problem and to push the fat man in the footbridge problem. However, the utility aspect (saving five people) overrules the omission bias in the former case. This is because there is no contact with the victims in the trolley problem. No contact does not fill the third principle. However, the third principle applies to the footbridge problem. Although there were

not many participants whose argument was based on the second principle (Cushman et al., 2006), it is still important. Many people do not feel that they are intentionally harming the victim by pulling the lever. However, they are likely to feel that they have intentionally inflicted bodily injury on the fat man by pushing him over the bridge even if their goal was to save the five people.

Roughly speaking, this distinction can be equated to that of dual process theory; deontic judgment corresponds to System 1, whereas utilitarian judgment corresponds to System 2 (e.g., Greene, 2013). For example, cognitive load was shown to pose more of an interference with utilitarian judgment than deontic judgment (Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2007). Generally, cognitive load selectively interferes with mental activity that needs cognitive capacity of System 2. This is compatible with dual process theory associating utilitarian moral judgment (approving of harmful actions that maximize positive consequences) with controlled cognitive processes and non-utilitarian moral judgment with automatic emotional responses.

In their fMRI study, Greene, Sommerville, Nystrom, Darley, and Cohen (2001) distinguished between the reasoning (cognitive) process and emotional process in moral judgment. According to their results, the brain regions associated with working memory (middle frontal gyrus (right) and parietal lobe) were recruited to solve an impersonal moral problem, whereas those associated with emotion (middle frontal gyrus (bilateral), posterior cingulate gyrus (bilateral), and angular gyrus) were used to solve a personal moral problem. Utilitarian judgment is likely to be made when solving an impersonal moral problem, whereas deontic judgment is likely to be made when solving a personal moral problem. Summarizing the results of some studies using neuroimaging technology, Greene (2013) proposed that the dorsolateral prefrontal cortex (DL-PFC), which is associated with cognitive control, is used in the making of utilitarian judgments, whereas the ventromedial prefrontal cortex (VM-PFC), which is associated with intuitive judgment, is used when making deontic judgments. The activation of the VM-PFC is transmitted to the amygdala, where it generates emotional responses.

PATHWAY TO A BETTER SOCIETY: IMPLICATIONS OF DUAL PROCESS THEORY

Domestic Globalization

The framework of dual process theory provides not only an explanation for changes in history but also a prescription for the future. As mentioned, there has been great progress with regard to the decline in murder, violence, fraud, and discrimination (Pinker, 2011). Can we continue this process in order to become a better society?

Contemporary society is characterized by globalization, a consequence of the division of labor. Beginning from self-sufficiency society like a tribal hunter-gather society, humans have taken division of labor in cooperation. Division of labor makes it possible to improve efficiency in production, thereby contributing to the prosperity of humans. Thus, humans have had surplus time for education (including publication), which has enhanced morality.

Division of labor is the driving force of globalization. Globalization began with the establishment of trade between different tribal societies. Contemporary globalization, both between and within countries, has been facilitated by industrialization. For example, in the case of Japan, before World War II, 40-50 percent of workers were farmers. However, this proportion drastically decreased after the war. As companies began offering more employment opportunities, many young workers preferred it over farming. These trends led to young Japanese people leaving their traditional communities for cities. Consequently, the traditional local communities collapsed, and urban areas, with their anonymous societies, became the norm.

The collapse of traditional communities is a problem faced by most industrial countries. For example, Putnam (2000) pointed out the gradual decrease in membership and the number of volunteers in many existing civic organizations such as religious groups, labor unions, and parent-teacher associations after World War II. These trends can be expressed as a decrease in social capital. Social capital broadly refers to those aspects of effectively functioning social groups that include factors like interpersonal relationships. In the traditional self-sufficient society, a social life with mutual aid used to be indispensable. The importance of social capital has now decreased. However, it is very likely that people are less able to find a way to ask for help, such as on losing a job, than they used to be.

However, it may be some people's desire to leave traditional societies. It is sometimes very stressful to live in traditional societies, which are dominated by rules to ensure cooperation. Breaking rules can lead to the imposition of sanctions by other community members. Those who left their traditional communities have chosen prosperity and a society without such rules. However, the problem, as pointed out by Putnam, may be more serious in countries, such as Japan, that have experienced rapid industrialization. Social changes are rapid, and they can be difficult to keep track of and conform to, particularly for elderly people. They are not used to a society where people meet anonymously and develop interpersonal relationships. They feel anxious when they do business with those whom they do not know well. These trends have resulted in some negative consequences in Japan. It has been reported that some Japanese people live without human relationships. Their social

isolation is a consequence of retirement, moving to another place, or divorce. They do not possess the social skills to establish new human relationships. Traditionally, the Japanese did not require such skills because in their traditional communities, rich relationships with community members were a given. Hence, they do not know how to develop such skills in a new context.

In spite of these negative consequences, we are unable to stop this globalization caused by industrialization. We have come not only to be prosperous but also to establish public morality through this process, as shown in the changes after World War II. Actually, the number of crimes increased slightly when traditional communities, which used to thrive on mutual surveillance, started to collapse. However, crimes, including violence and murder, have greatly decreased over the past 50 years.

International Globalization

The term "globalization" indicates the contemporary worldwide phenomenon in a narrow sense. Generally, I am not against this worldwide globalization for three reasons. The first reason is that it is both a consequence of and a move toward the global division of labor, which leads to prosperity. The second reason is that these trends are expected to lead to the decline of war. Globalization is leading to increased economic interdependence between countries. As previously mentioned, it is more beneficial for a country to trade with neighbor countries than to wage war, regardless of the result. The third reason is that globalization is expected to lead to a further decline in racial discrimination. Generally, discrimination is associated with in-group favoritism (Tajfel & Turner, 1979), which was stronger in traditional societies than it is in contemporary society. In other words, in-group favoritism is stronger in closed communities, as was the case with hunter-gatherers, and members from other communities are likely to be regarded as enemies or rivals. In-group favoritism and discrimination against other cultural group members declines when people from different cultural groups meet and understand each other. Globalization enhances communication, leading to mutual understanding. The decline in discrimination in the past 50 years can partially be attributed to the trend of globalization.

However, worldwide globalization has been criticized from the economic perspective. Summing up the existing discussions, there are two major criticisms. One is the apprehension that weaker industries, such as agriculture, are less likely to survive in the mega-competitive environment fostered by globalization. Famers in industrial countries are displeased with the cheap agricultural products imported from developing countries. At the same time, developing countries are dissatisfied

with rich countries, which tend to take advantage of their weak position to bring down the prices of agricultural products. The other criticism concerns the rate at which we are destroying nature and the environment. This concern is associated with a disgust of capitalism.

The biggest problem concerning contemporary globalization was posited by Murray (2017). He points out the problem caused by mass migration from non-European countries to Europe. There have been two reasons for the acceptance of mass migration. The first is based on the liberal idea of abandoning racism and propagating cultural relativism. Cultural relativism is the idea that an individual's cultural customs and practices should be understood based on that individual's own culture, and that there is no single standard based on which a culture can be considered superior. The second is Europeans' guilt regarding their colonization of Africa and the Middle East. According to Murray, the media has hesitated to report the criminals by the immigrants. Some criminals are strongly associated with cultural customs in their country of origin, which can completely differ from Europeans'. However, it is against cultural relativism to criticize such cultural customs. Under these circumstances, there have been many cultural conflicts between Europeans and newcomers.

Good Stories for a Better Future

Although there are some problems with contemporary globalization as a consequence of the global division of labor, we cannot put a stop to this phenomenon. Globalization is the engine that can fuel the decline of racism and the development of a prosperous world. The problem lies in the fact that people have not been able to get accustomed to these rapid changes over the past 50 years.

Contemporary civilization is not the ultimate stage of industrial, economic, and social development. There are still many unresolved problems. Division of labor enhances the development of both natural and social sciences and is facilitated by globalization. For example, although mass migration is causing many problems in Europe, the biggest underlying factors are the poverty, infringement of human rights, and intestine wars in the countries to which immigrants belong. If we stop immigration, their countries of origin remain as they are. I agree with the opinion that Europe should not accept illegal immigrants. However, putting an end to immigration is not the way out; rather, there is a need to foster environments where voices can speak out against authoritarian regimes, which bring infringement of human rights, in the countries to which immigrants belong. As mentioned above, Europeans have

hesitated to criticize the cultural customs and political regimes of other countries because of cultural relativism. However, there is no place for such hesitation when there is a need to send strong messages about the requirement of change in the non-democratic regimes in refugees' countries of origin. People need to use System 2 to find an optimal way to implement change. However, the output of System 2, weaker than that of System 1, is unable to drive such changes. For example, anger, which is a product of System 1 detecting inequality, may be used to force people to make a change to ensure a democratic regime. However, it may cause conflict if it is not controlled well by System 2. Another way is to use ToM to formulate a good story that can make people sympathize with those who are humiliated in despotic states. This emotional sympathy can be the energy to drive people, including politicians and journalists, to stop dictatorships. This energy can arise within despotic states.

As stories can be a double-edged sword, they should be well examined by System 2. For example, *The Merchant of Venice* by Shakespeare is frequently staged today. The audience may share a hatred for the Jewish moneylender, Shylock, who is greedy and cruel. However, this play is potentially troubling to modern audiences because of its central themes, which can easily appear anti-Semitic.

Generally, the role of scientists (social and natural sciences) is to determine how to solve problems, such as global warming, incurable diseases, religious conflicts, dictatorships, economic recession and poverty, and moral denegation. However, novelists and journalists take upon themselves the responsibility of creating stories that can drive people toward change. For example, a novel depicting the tragedy of war may lead people to commit themselves to the anti-war movement. Journalistic coverage of the malnutrition of young children in a very poor country may increase donations to UNICEF and make politicians realize that poverty is a problem that cannot be ignored. In other words, these are ways to put to use the identifiable victim effect (Kogut & Ritov, 2005).

CONCLUSION

Does System 2 suppress or revise the negative output of System 1? The general answer is that when it is associated with strong emotions (fear and/or anger), the output is more unlikely to be suppressed or revised. I examined two natural historical experiments to test this research question.

The first is the changes in 17th century Europe. There was a decline in war, torture, cruel punishment, and religious persecution. Pinker (2011) proposes that one of the influential factors in these changes is the prevalence of novels. This idea

can be developed in terms of ToM, the distinction between deontic and utilitarian judgment, and the identifiable victim effect. The second is the changes after World War II; there has been a decline in discrimination and crimes including murder, violence, and theft. The major factor responsible for this is the spread of education. The concepts of democracy, equality, and rationality have been taught around the world. The spread of education may have caused the Flynn effect, such that intelligence test scores have got higher in many parts of the world over the 20t^{h} century (Flynn, 2012). I am not certain if this reflects the ability of System 2 to revise the negative output of System 1, but it is very interesting that these changes have co-occurred after World War II.

The distinction between deontic judgment and utilitarian judgment in moral reasoning corresponds to the one between System 1 and System 2. Morals in the contemporary world have been established on the basis of a balance between the two systems. System 1 brings deontic judgment, whereas System 2 makes it possible to make utilitarian judgments to control deontic judgments. However, it is deontic judgment that leads to action. Therefore, political leaders, journalists, and novelists should understand utilitarian judgment by experts (scientists and researchers) and choose a good story that evokes sympathy for those who are discriminated against and so on. Utilitarian moral judgment and deontic moral judgment are like the wheels, the vehicle being a better society.

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KEY TERMS AND DEFINITIONS

Deontology/Utilitarianism: Deontology is a normative ethical theory concerning what is or should be the norm based on human duty, whereas utilitarianism is a consequentialist ethical theory promoting actions that maximize happiness and well-being for the majority of the population.

Dual Process Theory: This theory supposes that there is a distinction between an evolutionarily old heuristic system (intuitive mind) and an evolutionarily recent analytic system (analytical mind), and that the former supports processing that is implicit, automatic, fast, intuitive, contextual, and associative, whereas the latter supports processing that is explicit, controlled, slow, reflective, abstract, and rule-based.

Identifiable Victim Effect: This is the tendency of individuals to feel more sympathy and to offer greater aid to a specific, identifiable person than a large, vaguely defined group with the same need.

Noble Savage: The term "noble savage," which originated in the 17th century, refers to the idea that humans are essentially good, and that civilization, with its money, weapons, and so on, is the source of all evil.

Theory of Mind: The concept involved in theory of mind is an ability to predict mental states, which is used to understand and explain others' acts.

Section 2

Reasoning in the Modern World

Chapter 5
Why Do You Believe in Pseudoscience or Disbelieve in Science?

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ABSTRACT

People sometimes hold irrational beliefs even when empirical evidence obviously debunks claims central to beliefs. This chapter reviews empirical studies exploring underlying psychological processes of holding empirically suspect beliefs with a particular focus on belief in pseudoscience. The author explains empirical findings from a dual process view of thinking. Recent studies show individuals with higher analytic tendency exhibit more ideologically polarized reasoning than those with lower analytical tendency. These results suggest a significance of motivated reasoning in order to fully understand the psychological mechanism of everyday beliefs. Future research suggestions emphasize remaining questions, such as a developmental time course of, a cultural diversity of, and evolutional origins and functions of the belief in pseudoscience.

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WHAT IS PSEUDOSCIENCE?

People have various beliefs about a wide variety of real-world issues. Some beliefs may be strengthened through a process of empirical validation, whereas others may be weakened. However, people sometimes hold epistemically unwarranted beliefs (Lobato, Mendoza, Sims, & Chin, 2014) where the central claim of the belief was not supported by sound evidence. For example, a recent survey on paranormal belief among an American population (Chapman University Survey of American Fears, 2018) showed that more than half of participants believed that places can be haunted by spirits and almost a quarter of individuals believed in bigfoot and fortune-telling. This survey also indicated that about three out of four participants held at least one paranormal belief and that those beliefs have risen rapidly compared to the same survey conducted two years before. Furthermore, it is fresh in our memory that the Oxford Dictionary has selected "post-truth" as its international word of the year in 2016 after a steep increase in usage following Brexit vote and the US presidential election. In line with a growing permeation of the word, researchers are also interested in other form of irrational beliefs, such as "fake news" and conspiracy theory. For example, you will find that a Google Scholar search of the term "fake news" returned less than 1,000 hits in 2015, however, this has increased to 7,000 in 2017 and 12,000 in 2018.

A conspiracy theory is defined, in general, as "the conviction that a group of actors meets in secret agreement with the purpose of attaining some malevolent goal" (van Prooijen & van Vugt, 2018, p. 770). Studies have shown that a non-negligible number of people hold the beliefs in conspiracy theory as well as beliefs in the paranormal. For example, more than one third of American suspected that the 9/11 attacks were 'inside job' (Stempel, Hargrove, & Stempel, 2007). Furthermore, the recent opinion poll by YouGov-Cambridge Globalism Project indicated that 17% of Americans believed that the man-made global warming is a hoax (Milman & Harvey, 2019), and that a certain number of people in European countries, even though the proportion was less than an American population, also denied the man-made climate change. A conspiracy theory sometimes goes with the science denialism, such as the rejection of vaccinations and genetically-modified foods as well as climate science denial (Kata, 2010; Lewandowsky, Gignac, & Oberauer, 2013). The science denialism itself is not necessarily pseudoscientific, but some forms of pseudoscience entails pseudo-theory promotion (Hansson, 2017). For instance, creationists have been religiously motivated by the rejection of biological evolution and have often made out that their claims are an alternative theory of the genesis of life.

These findings have shown that even people living in the highly civilized countries hold a number of irrational beliefs that are deficient in or against empirical evidence. In some cases, those epistemically unwarranted beliefs are regarded as harmless, however other beliefs can cause undesirable consequences at the individual and societal levels. For example, unjustifiable attitudes against vaccinations may increase the risk of being ill for individuals, and as a result, may pose a major threat to public health and economy. Therefore, understanding the psychological processes underlying these epistemically unwarranted beliefs is growing in importance in our modern society.

This chapter focuses, among the various types of irrational beliefs, on beliefs in pseudoscience and psychological mechanism underlying the belief. Compared to the other forms of empirically unwarranted beliefs, the belief in pseudoscience has captured little attention in the domain of psychological science. Rather, the discussion on pseudoscience has been considered as a part of general themes in the philosophy of science, namely the demarcation problem (Hansson, 2017). Setting the boundary between authentic science and pseudoscience has been a controversial issue in philosophy of science for a long time, however, it is often said that pseudoscience is masqueraded to be scientific and factual, but are not incompatible with scientific methods and that it stray far from the scientific mainstream (see, Fasce & Picó, 2019; Hansson, 2017). It is not the scope of this chapter to elaborate what exactly a pseudoscience (or a science denialism) is, therefore the pseudoscience here is broadly defined as an activity or a set of claims that pretends to be scientific but is not based on sound evidence, disregards the widely accepted scientific methods, and consequently holds false assertions about the material world. In this regard, a science denialism here can be regarded as a part of pseudoscience.

In addition, the belief in pseudoscience can also be understood as a part of epistemically unwarranted beliefs. As the name suggests, the epistemically unwarranted belief refer to the conviction where the central claim of the belief failed to achieve totality of evidence or, in other words, *epistemic warrant* (Lobato et al., 2014). Accordingly, beliefs in paranormal, conspiracy theory, and pseudoscience can be defined as a major component of epistemically unwarranted beliefs. Although, by definition, a pseudoscience is not identical to the conspiracy theory and the paranormal, it may not be so problematic if we refer to those three forms of belief collectively as epistemically unwarranted since many studies have shown a close relationship between those beliefs. In the next section, I will briefly review the existing literature supporting this assumption. Then, this chapter will focus on how the believers are different from the skeptics and discuss why we hold those irrational beliefs despite of refuting evidence.

WHO BELIEVES IN PSEUDOSCIENCE?

As previously noted, the epistemically unwarranted beliefs share several common characteristics. For one thing, an epistemically unwarranted belief sometimes has grown as a complex amalgam of paranormal, conspiratorial and pseudoscientific claim. For example, the central claim of the creationism, namely the Genesis account of the emergence of the universe and the life, evidently violates natural or scientific laws, therefore, it is a representative example of a paranormal belief that is against a scientific understanding of the material world. In addition, protagonists of creationism are likely to have a conviction that the theory of biological evolution is an atheist, or even devil's, conspiracy (Boudry & Braeckman, 2011; Hansson, 2017). This suggests a kinship between beliefs in the paranormal, conspiracy theory and pseudoscience. Empirical studies provide further support for this relationship showing that individuals having a particular type of belief are also likely to have other belief. For instance, the protagonist of a specific conspiracy theory tend to have other conspiracy beliefs (e.g., Goertzel, 1994; Swami et al., 2011). Moreover, studies also indicated that believers of the conspiracy theory tended to believe in the paranormal allegation (e.g., Brotherton, French, & Pickering, 2013; Darwin, Neave, & Holmes, 2011; Lobato et al., 2014; Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015), and that the science denialism often comes with conspiracist ideation (for example, climate science denial, Aldhous, 2011; anti-vaccinations, Hornsey, Harris, & Fielding, 2018; evolution theory denial, Wagner-Egger, Delouvée, Gauvrit, & Dieguez, 2018). These findings suggest a family resemblance between a variety of epistemically unwarranted beliefs.

You may be curious about differences between the believers and the skeptics. From a conventional view of human rationality, people might consider that those who have such irrational beliefs are intellectually incompetent; and earlier research have shown that less-trained or incompetent people tended to have stronger beliefs compared to well-trained people (Otis & Alcock, 1982). Some researchers have also suggested that malfunctioning cognition was the primary factor of such beliefs (e.g., Blackmore & Trościanko, 1985; Musch & Ehrenberg, 2002; Roberts & Seager, 1999). Those studies suggested that the lack of logical and probabilistic reasoning skills might be at the heart of several irrational beliefs.

However, recent studies have shown that cognitive style rather than abilities explained better our epistemically unwarranted beliefs. According to the *default interventionist approach* of dual process theory of thinking (Evans, 2007; Kahneman & Frederick, 2002; Stanovich, 2009), our thought consists of two distinct processes.

The first process is evolutionary-old, fast, autonomous, undemanding, and intuitive Type-1 process; the other is evolutionary-new, slow, conscious, demanding, and analytic Type-2 process. A dual process account assumes that the epistemically unwarranted beliefs come from intuitive processes and serve as our cognitive default but might be suppressed thorough a deliberative process.

To support this view, a bunch of empirical studies have shown that beliefs are positively associated with intuitive cognition but negatively associated with analytic cognition. For example, it is known that people with a high tendency toward experiential thinking (Epstein, Pacini, Denes-Raj, & Heier, 1996) are likely to have a belief in the paranormal (Aarnio & Lindeman, 2005) and that intuitive and lay ontological confusion in one's core knowledge about physical, biological, and psychological phenomena, in other words, knowledge about material world, predicts religious and paranormal attribution of beliefs (e.g., Lindeman, Svedholm, Takada, Lönnqvist, & Verkasalo, 2011; Lobato et al., 2014). Additionally, even professional physical scientists could not reject teleological explanations if they were asked to engage in the task under speed despite maintaining high accuracy (Kelemen, Rottman, & Seston, 2013). These studies have suggested that epistemically unwarranted beliefs are in congruent with our intuitive understanding of the world and serve as a cognitive default for various types of thinking.

On the other hand, the analytic and reflective Type-2 thinking debunks unsubstantiated beliefs. For instance, studies found that people who scored high in the Cognitive Reflection Test (CRT, Frederick, 2005) were likely to show religious disbelief (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012; Shenhav, Rand, & Greene, 2012). The CRT is a short quiz-type questionnaire aimed to measure a tendency toward analytical thinking. For example, in the famous bat-and-ball problem, participants are presented with the following question:"A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?" An initial answer that comes up easily to one's mind is $0.10; however, this intuitive answer is wrong since a difference between bat and ball is less than one dollar. The correct answer ($0.50) needs more deliberative analysis of the question. In other words, the CRT requires participants to engage in an analytic and reflective mode of thought and to override an overhasty answer. Considering the findings indicating that religious belief is a natural by-product of intuitive cognitive processes (see, Shenhav et al., 2012), the negative link between the CRT and religious belief suggests that an intuitive belief could be overridden by the reflective Type 2 process. Similar negative associations with the CRT and other analytic thinking dispositions, such

as the Rationality Scale of Rational/Experiential Multimodal Inventory (Norris & Epstein, 2011) and the Actively-Openminded Thinking Scale (Stanovich & West, 1997), were also found for belief in the paranormal (Pennycook et al., 2012; Svedholm & Lindeman, 2013) and conspiracy theory (Ståhl & van Prooijen, 2018; Swami, Voracek, Stieger, Tran, & Furnham, 2014; van Prooijen, 2017).

A study conducted by Pennycook and colleagues (Pennycook, Cheyne, Koehler, & Fugelsang, 2013) provided further support by indicating that religious believers were more likely to commit a belief bias—a reasoning based on the believability of the conclusion in lieu of the logical validity—in syllogistic reasoning. The belief bias task requires individuals to decide the validity of the conclusion of syllogism in light of the logical structure, but not of the acceptability from common sense. Therefore, individuals are encouraged to ignore an initial acceptability-based answer that came up easily to one's mind, and then, to provide the correct solution reflectively. Accordingly, those who tended to show the belief bias are less analytic and, as a result, are susceptible to irrational beliefs.

Although psychological processes underlying belief in pseudoscience has captured less academic interests compared to other irrational beliefs, several theoretical considerations and empirical studies suggested that pseudoscientific beliefs shared the fundamental characteristics with other forms of epistemically unwarranted beliefs. In fact, studies have shown that individuals who believe in pseudoscientific claim, particularly complementary and alternative medicine, were less analytic (e.g., Browne, Thomson, Rockloff, & Pennycook, 2015; Lindeman, 2011). In addition, Fasce and Picó (2019) recently developed a new scale intended to measure a broader range of beliefs in pseudoscience (Pseudoscientific Belief Scale; PSEUDO). In an attempt to establish the constructive validity of the scale, they found that two subcategories of pseudoscience (pseudo-theory promotion and science denialism) were negatively associated with CRT. However, despite these findings, the link between the skepticism to pseudoscience and analytic thinking seems to be somewhat complex compared to religious and paranormal beliefs. For instance, Lobato et al. (2014) failed to find considerable relationship between pseudoscientific belief with core ontological confusions and need for cognition (NFC, Cacioppo & Petty, 1982), that is a tendency toward enjoying and engaging in cognitively demanding activities. In addition, Japanese participants who scored high in the self-rated measure of analytic cognition tended to have, surprisingly, stronger beliefs in paranormal and pseudoscience (Karasawa & Tsukimoto, 2010; Majima, 2015) than less 'analytic' people. These findings may suggest that psychological processes underlying an acceptance of pseudoscientific claim is slightly different in contrast to other forms of epistemically unfounded beliefs.

WHY DO WE BELIEVE IN PSEUDOSCIENCE?

As mentioned in the previous section, the protagonists of irrational belief are less likely to adopt analytic and reflective forms of cognition. Existing findings also showed that empirically unwarranted beliefs can be overcome through education and/or one's development. These findings suggest that irrational beliefs are rooted in our intuitive cognition and can be weakened or suppressed by the effortful analytic process, namely Type 2 process in the dual process framework. This explanation is consistent with *default interventionist* model of dual process theory that a quick, but sometimes inaccurate intuitive (i.e. Type 1 driven) response can be corrected by a slow but deliberative Type 2 process of thought.

It is worth noting that the tendency toward analytic thinking does not necessarily decrease an inclination toward epistemically unwarranted beliefs. In fact, Gervais et al. (2018) found that analytic cognition is associated with religious disbelief only in a religious population. In their study, the authors collected data from a large and diverse global sample across 13 countries and indicated that, despite an overall positive connection with religious disbelief, the CRT is not a useful predictor of belief in less-religious countries. From this result, Gervais et al. (2018) argued that cognitive reflection might be an indicator of a tendency to challenge prevalent norms observed in one's culture. Furthermore, although it is known that analytic cognition can promote a better understanding of scientific information, such as biological evolution and climate change (Gervais, 2015; Lobato & Zimmerman, 2018), previous studies have also exhibited contradictory results about a reflection-belief link. To name a few, Browne et al. (2015) revealed that reflective thinking could not explain vaccination endorsement; and Kahan and colleagues have shown that the highly analytic individuals treated empirical evidence in a biased way to support claims that conformed to their political orientation (Kahan, 2013; Kahan, Peters, Dawson, & Slovic, 2017). In other words, people tend to adopt ideologically motivated cognition (Kunda, 1990) to show their sympathy for the group that is important to personal well-being. In that sense, highly reflective people used their quantitative reasoning ability to protect identity-congruent beliefs. However, it does not necessarily mean that ideologically motivated reasoning occurred due to reasoning deficiency, rather it suggests that motivated cognition can be seen as a result of reasoning adaptation (Kahan, 2013).

In addition to a proximate cause of belief such as individual differences in cognitive style, recent studies in this domain started to focus on distal cause of beliefs, namely evolutional origins and functions. For example, van Prooijen and van Vugt (2018) recently compared two evolutionary hypotheses about the origins of the conspiracy beliefs: natural *by-product* hypothesis and *adaptive-conspiracism* hypothesis. *By-product* explanation suggests that conspiracy theories emerged as a result of a growing

capacity of brain which enables us to think and reason sophisticatedly. Particularly, it assumes that evolved human psychological mechanisms such as pattern perception, agency detection, threat management, and alliance detection cooperatively prompt humans to be vulnerable to conspiracy theories. In fact, studies have revealed that conspiracies beliefs are positively associated with those evolved mechanisms, for example, illusory pattern perception (van Prooijen, Douglas, & De Inocencio, 2018) and agency detection (Douglas, Sutton, Callan, Dawtry, & Harvey, 2016). However, since this explanation assumes that conspiracy beliefs are a natural by-product of our psychological mechanisms evolved for different purposes, the belief itself does not have any practical function that contribute to human adaptation. On the other hand, *adaptive-conspiracism* explanation assumes that beliefs reflect evolved psychological mechanisms encouraging the detection of dangerous coalitions. The authors reviewed existing literatures from psychology, anthropology, history and political science and concluded that psychological mechanisms underlying belief in the conspiracy theory is a part of human mind specifically aimed to defend ourselves from harmful coalitions, rather than a by-product of other adaptive functions (for detailed discussions, see van Prooijen & van Vugt, 2018). Similarly, Norenzayan et al. (2016) proposed an evolutionary framework synthesizing both by-product and adaptionist approaches of the religious belief. Their theory explains that, at the beginning, religious beliefs emerged as a natural but nonadaptive by-product of our cognitive functions, however particular forms of religion that are advantageous for prosocial adaptation, such as increasing in productivity, cooperation and competitiveness of the society, have spread as these successful groups grew in a long-term cultural evolution.

Although it remains unclear that those evolutional frameworks can be also applied to beliefs in the pseudoscience, scholars have started to discuss about the evolutional origins of pseudoscientific beliefs. For instance, Blancke, Boudry, and Pigliucci (2017) proposed a beneficial evolutional framework about the cultural evolution of pseudoscience, more precisely the cultural mimicry of science beneficial for pseudoscience. According to Blancke et al. (2017), science holds a prestigious position due to its cultural and epistemic authority in the current society, therefore an imitation of or the pretense of science is an effective strategy for pseudoscience to exploit 'accuracy' of information and trustworthiness of the sender (*epistemic vigilance*, Sperber et al., 2010), to preserve their 'scientific' appearance, and to take advantage of our cognitive and motivational nature that is easily satisfied with an intuitively fascinating argument (*epistemic negligence*). In addition, Mercier, Majima, and Miton (2018) found that those who believed in pseudoscientific myths were more likely to spread the myth to others. They also suggested that the potential driving factor of transmissions was individual's conviction that holding the belief would enhance one's competent outlook.

The cultural evolutionary account of pseudoscience is getting to capture academic interests in both theoretically and empirically, however there remains unresolved questions about the nature of pseudoscientific belief as well as science denialism. In the final section, I will briefly summarize key arguments of this chapter and provide suggestions for future research.

CONCLUDING REMARKS AND FUTURE DIRECTION

Taken together, what we know about psychological process underlying belief in pseudoscience can be summarized as follows: First, individuals who have certain epistemically unwarranted belief are likely to have other forms of such beliefs. Second, epistemically unwarranted beliefs are grounded in our intuitive cognition but can be weakened by a deliberative and analytic mode of thought. Third, on the other hand, analytic thinking is more likely to foster ideologically motivated reasoning (Kunda, 1990) than override so-called incorrect intuitive response when individuals have a strong political orientation. Fourth, we should also take into account of cultural evolutionary aspects of irrational beliefs.

However, it is still unclear which beliefs came before others. In other words, what kind of epistemically unwarranted beliefs do we have ahead of other beliefs in our earlier developmental stage? It seems unlikely that infants have complex pseudoscientific or conspiracist beliefs as seen in adult populations, however, studies have shown that children often show anthropomorphic understanding of non-human objects and are good at agency detection (Epley, Waytz, & Cacioppo, 2007; Kelemen, 2004). Considering the fact that anthropomorphism and higher sensitivity in agency detection were sometimes associated with epistemically unwarranted beliefs, such as a belief in the paranormal (Douglas et al., 2016) and conspiracy theory (Elk, 2013), we can speculate that children firstly acquire this 'unsophisticated' understanding of the world, then develop the earlier forms of questionable beliefs, such as religious and paranormal ones. These initial beliefs may then lead to more complex forms of epistemically unwarranted beliefs such as pseudoscience and conspiracy theory. However, the developmental time course for the formation of irrational beliefs remains unclear, therefore more extensive works, both in terms of theoretical and empirical research, is needed.

In addition, future research in this domain should explore how culture, more precisely norms defined by culture, works as a mediator between belief and cognitive and motivational factors. As the findings suggest, people tend to reason

about politically controversial issues in a way that is favorable for their political orientation. Accordingly, people who have greater disposition and ability to reason analytically display their reflective thinking ability purposely in justifications of favorable evidence about the issue. However, most of the empirical findings supporting this explanation have been obtained from US samples, and participants in these studies identified their political orientation on a one-dimensional liberal-conservative or Republican-Democrat scale. At this moment in time, there is sufficient reason to question the universality of ideologically motivated reasoning in epistemically unwarranted beliefs across cultures, and therefore investigating whether this explanation is also applicable to believers from so-called non-WEIRD (West, Educated, Industrialized, Rich and Democratic, Henrich, Heine, & Norenzayan, 2010) populations would be a fruitful direction of future research. In addition to politically motivated cognition, personal motivation such as achieving a feeling of control, more broadly sense-making motivation (van Prooijen & van Dijk, 2014), may play some role in holding beliefs. In fact, paranormal and conspiracy beliefs are known to be positively associated with illusory pattern perception (van Prooijen et al., 2018) and reception of 'pseudo-profound bullshit' (Pennycook et al., 2015), that is, a tendency toward seeing profoundness in meaningless sentence.

Finally, the evolutional origins and functions of pseudoscientific belief need further considerations from both theoretical and empirical perspective. Empirical findings suggest that pseudoscientific beliefs may share common characteristics with other forms of irrational beliefs, and, in fact, several pseudoscientific beliefs involve a set of paranormal and conspiratorial claims. However, regardless of whether a pseudoscientific belief is a by-product of our cognitive functions or a result of adaptation, the belief in pseudoscience has several differences from beliefs in the paranormal and conspiracy theory that should be considered. For example, it is suspicious that pseudoscientific beliefs are developed in order to protect ourselves from hostile coalition as well as the conspiracy theory. And importantly, pseudoscience usually imitates its counterpart, namely science, however a cultural mimicry of the counterpart may not be seen in other forms of epistemically unwarranted beliefs. To fully understand psychological mechanisms underlying belief in pseudoscience and rejection of science, it will be a fruitful direction to investigate not just individual's cognitive traits (i.e. proximate cause) but also cultural and motivational factors (distal cause) and their interaction.

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Chapter 6
Lexical Basis of Causal Attribution and Explanation

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ABSTRACT

This chapter explains how laypeople generate and evaluate explanations. Traditionally, deliberate processing is assumed to be involved in generating and evaluating explanations. However, the author proposes two stages account for causal attribution and explanation to explain how laypeople generate and evaluate explanations quickly: a semi-autonomous processing stage which is primarily dependent on the lexical information of the verb, and a deliberate processing stage that takes many factors into account. The author proposes that verb types play an important role in determining the type of explanation and calls it verb cue hypothesis. In addition, the author proposes that verb cue hypothesis works as a cognitive shortcut that comprises the first stage of the two-stages account. Empirical evidence for the verb cue hypothesis was found in studies on causal attribution and explanation type preference.

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INTRODUCTION

We live in a world where change is regarded as a norm, not an exception. Furthermore, new rules and new instruments are introduced in a record setting speed. In this rapidly changing world, we need to understand people, objects and events, especially those that are unusual, in order to survive. For instance, we need to know why my friend behaves differently today, why the doorknob is placed where it is, or why it rained heavily yesterday. If the problem at hand is important, we try to get the reasonable answer. And when we do not know the reasonable answer, we either try to find the answer for ourselves or ask other people to give the answers and try to explain why the answers might be right. The processes of figuring out the cause, reason, or the explanation have been studied as causal attribution and explanation in social psychology and cognitive psychology.

One interesting thing in the process is that we are quite good at generating and evaluating the explanations (Cimpian, 2015). As most of the questions we want to know is either why question (e.g., why the accident happened or why coins are round in most cased) or the how question (e.g., how ice melts into water (Lombrozo & Wilkenfeld, forthcoming), the fact that we are good at evaluating explanations suggests that there can be some easy way to figure out the type of explanation that is adequate in the situation at an early stage of processing, such as at the lexical level. I will call the idea that verbs play important role in determining the type of explanation as the verb cue hypothesis. However, we also need some mechanisms that check the validity of the initial judgment because we sometimes look for reasons other than the one we initially thought. So in this chapter, I am going to propose a two processing stages account for causal attribution and explanation: A semi-autonomous processing stage which is primarily dependent on the lexical information, and a deliberate processing stage that takes many factors into account.

There will be two sections in the chapter. The lexical basis of causal attribution related with the interpersonal verbs will be covered in the first section. More specifically, the characteristics of interpersonal verbs, the interpretational bias of interpersonal verbs, and the time course of the interpretation bias of interpersonal verbs will be covered. The lexical basis of explanation type preference will be covered in the second section. In the second section, basic issues related with explanation and explanation type preference will be covered. Afterwards, lexical basis of explanation type preference, which will be the first stage of the two stages account will be proposed. Finally, in the concluding section, implications of two processing stages model of causal attribution and explanation and ideas for future research will be proposed.

BACKGROUND

When we encounter some behavior or events that we do not expect, we try to identify the causes of the behavior or the event. There are two stages in identifying the causes: First, we have to identify the parts that need causal explanation. Then we have to generate and select the most adequate causes from a number of possible causes. Of the two stages, the first stage is not difficult in everyday settings because we usually know which part is unexpected. What we usually do in everyday settings is the second stage, generating and selecting the reasonable causes, both of which need domain knowledge in most cases. Furthermore, there are many cues in everyday settings that help determine the type of explanation.

Therefore, it is not easy to test the verb cue hypothesis, the hypothesis that verbs play important role in determining the type of explanation, in everyday settings. To test the verb cue hypothesis, there should be as little information as possible. Typical causal attribution studies in social psychology do not help either. In typical causal attribution studies, the participants are asked to choose between an internal cause (i.e., actor) and an external cause (i.e., situation) after they read a scenario that describes the characteristics of the actor and the situation and the event. We learn quite a lot about the factors affecting causal attribution with this paradigm. However, it is not a good tool to test the verbs cue hypothesis because many factors are described in the typical scenario.

What can be a good tool to test the verb cue hypothesis? Minimal sentences can be a good tool, because they have only three constituents, NP1 verb NP2. Furthermore, minimal sentences are not an artificial material as a tool of studying causal attribution because explanations are usually given in simple short sentences. Sentences consist of several constituents, and verbs play central roles in assigning thematic roles to the constituents of a sentence. We understand the meaning of a sentence based on the thematic roles of its constituents. Let's read the two sentences, *Jack likes Susan*, and *Susan likes Jack*. In the two sentences, Jack takes different roles. Jack takes the role of agent in the first sentence. Jack is the person who likes Susan. However, Jack takes the role of patient in the second sentence. That is, Jack is the person who is liked by Susan. As Jack takes different thematic roles in the two sentences, we form different mental models of the two sentences, and judge that the two sentences differ in meaning.

As verbs are crucial in assigning thematic roles, we might think that we can explain the sentence understanding process just by identifying the rules we use in assigning thematic roles. From that sense, the idea that we start assigning thematic

roles after we read the whole sentence (let's call it wait hypothesis) looks quite attractive. However, the wait hypothesis is not a plausible idea because our working memory where this mental process is supposed to take place is limited in capacity. To circumvent the limits of working memory capacity, we need to use some shortcuts. The immediacy principle emphasizes the fact that we use shortcuts in sentence understanding (Just & Carpenter, 1980). The phenomenon of garden path sentences shows that we stat to assign syntactic roles before we reach the end of the sentence (Frazier & Fodor, 1978).

Then what can be used as cues of the shortcuts? As many sentences, including the minimal sentences, have a NP1 verb NP2 structure as a basic structure, we can pick two candidates as possible cues for the shortcut: verbs and the relationship between NP1 and NP2. The first candidate is the verb. As verbs are critical in assigning thematic roles, the information in verbs, i.e., thematic roles that usually accompany the particular verb, can be a very useful cue (Fillmore, 1968). In addition, the relationship between NP1 and NP2 can be a useful cue if there is some well-known relationship between the two NPs, such as a teacher and a student, or a hammer and a nail. However, the relationship between the two NPs is less useful than the verb, because the relationship between the two NPs is determined by the verb. In addition, NP2 is presented after the verb in English. Based on this, I propose that verbs set tentative frames of events that can lead readers/listeners to expect which can take the role of cause or consequence in the sentence.

LEXICAL BASIS OF CAUSAL ATTRIBUTION: INTERPERSONAL VERBS AND IMPLICIT CAUSALITY

Interpersonal Verbs and Implicit Causality

In the previous section, the roles of verbs in thematic role assignment process have been briefly covered. Verbs, however, work more than that. Verbs also affect processes related with causal attribution and explanation. As has been mentioned before, the role of verbs in causal attribution and explanation can be most effectively investigated using minimal sentences. So the discussion on the role of verbs in causal attribution and explanation will be based on studies using minimal sentences.

A specific type of verbs called interpersonal verbs is particularly useful in studying the role of verbs in causal attribution and explanation. Interpersonal verbs are transitive verbs that describe interactions between people (e.g., Ted frightens/

kisses Mary). There are two NPs in a minimal sentence, and there is no restrictions concerning the nature of the NPs. However, when the verb is an interpersonal verb, either NP can be the cause of the event described in the sentence as both NPs are human beings. Consequently, the role of verbs in causal attribution can be most effectively investigated using sentences with interpersonal verbs. Furthermore, if we share some implicit knowledge about the cause of a specific event, one of the two NPs will be more frequently mentioned as the cause of the event.

Interpersonal verbs are special in two senses (Bott & Solstad, 2014). First, sentences with interpersonal verbs are much more likely to produce explanation than sentences without interpersonal verbs (Kehler et al. 2008). Second, sentences with interpersonal verbs show preference for certain type of explanation. In a sentence with interpersonal verbs, either of the two NPs can be the cause of the event described in the sentence. Furthermore, if we share implicit knowledge about the causal structure of the event, one of the two NPs will be more likely to be mentioned as a cause. Consequently, sentences with interpersonal verbs are the best tool in testing the role of verbs in causal attribution, if the verb cue hypothesis is right.

In fact, many of the interpersonal verbs have a preference for certain type of explanation. For instance, when participants are asked to complete a sentence "*John fascinated Mary, because,"* they produce explanations where the subject of the main sentence is used as a subject of the clause starting with because (e.g., because John made many kinds of funny faces) more than explanations where the object of the main sentence is used as a subject of the clause starting with because (e.g., because Mary wanted to know people around her). When the former type where the subject of the main sentence is used as a subject of a sentence following *because* is used more frequently to a certain verb, the verb has an NP1 bias. When the latter type is used more frequently to a specific verb, then the verb has an NP2 bias. Many psychologists have found that some interpersonal verbs have strong NP1 bias, whereas some other verbs have strong NP2 bias, which is sometimes called interpretation bias (Bott & Solstad, 2014; Hartshone & Snedecker, 2013; Rudolph & Försterling, 1997). Psychologists have explained the interpretation bias in terms of the implicit causality of the verbs. That is, they proposed that verbs have some information about the causality of the event described by the verb, and call it as the implicit causality of the verbs. Interpretation bias due to implicit causality is sometimes called as IC bias.

The interpretation bias was first reported in an attribution study of Abelson and Kanouse in 1966, and has been replicated many times afterwards. In a study by Garvey & Carramaza (1974), participants were given a sentence, such as "The

prisoner confessed to the guard because he ___" or "The mother punished her daughter because she ___" and asked to complete the sentence. To the first sentence, participants produced sentences like "The prisoner confessed to the guard because he wanted to be released," where he refers to the NP1. To the second sentence, on the other hand, participants produced sentences like "The mother punished her daughter because she broke an antique vase" where she refers to the NP2. In the study, it was found that some verbs have an NP1 bias (e.g., confess, join, sell, telephone, chase, approach), and other verbs have an NP2 bias (e.g., kill, fear, criticize, blame, punish, scold, praise, congratulate, admire). As the sentence is a minimal sentence, and the two NPs are of the same gender, only the verb can be the cause of the bias. Garvey & Carramaza interpreted that each verb carries with it a weighting toward one or the other direction of attribution of cause.

The implicit causality of the interpersonal verbs has been studied using a number of different tasks, not only sentence completion task, but also causal attribution task and causality rating task. For instance, Garvey, Caramazza, and Yates (1976) let participants read sentences such as "Mary likes Lisa because she is nice" or "Mary protects Lisa because she is nice," and then asked them to answer "Who is she?" Most participants identified Lisa (the grammatical object of the sentence) as she in Sentence 1 and Mary (the grammatical subject of the sentence) as she in Sentence 2.

Brown & Fish (1983), on the other hand, ask participants rate the likelihood of each NP as a cause of the event described in a sentence with interpersonal verb. For instance, for a sentence, *Ted likes Paul*, participants are asked to answer how Ted or Paul is likely to be the cause by choosing on a 9-point scale ranging from not likely to definitely likely.

Regardless of the tasks, results of the three tasks showed a pattern that matches that of the interpretation bias in sentence completion tasks. The fact that three kinds of tasks show similar pattern means that the implicit causality of the verbs exerts quite consistent influence on causal judgment.

As many interpersonal verbs show either NP1 bias or NP2 bias, psychologists proposed a number of classifications of interpersonal verbs (e.g., Au, 1986; Brown & Fish, 1983; Hoffman & Tchir, 1990; Rudolph & Försterling, 1997; Semin & Fiedler, 1988). The distinction between state verbs and action verbs has been widely used in early studies on the role of verbs on causal attribution (e.g., Abelson & Kanouse, 1966). State verbs refers to the verbs that describe state of one of the two person in the sentence (e.g, like), and action verbs refers to the verbs that describe action (e.g., help). The distinction is quite useful, but not always successful, in predicting the pattern of causal attribution: It has been found in early studies that in sentences

with action verbs, cause is usually attributed to the subject of a sentence. However, in sentences with state verbs, cause is sometimes attributed to the subject of a sentence, and sometimes to the object of a sentence. Brown & Fish (1983) and Rudolph & Försterling (1997) tried to solve the problem by classifying interpersonal verbs into three or four types.

Brown & Fish (1983) tried to solve this problem by using the concept of semantic roles in classifying verbs. The concept "semantic roles" comes from the concept "universal verbal schemas" in the theory of linguistic universals (e.g., Fillmore, 1968). The universal schemas provide the semantic roles to the constituents of a sentence. One important feature of semantic roles is that a constituent that takes a certain semantic role (e.g., experiencer) is not always placed at a fixed position in a sentence. It can be a subject of a sentence or an object of a sentence depending on the verb of the sentence.

Brown & Fish (1983) used four semantic roles in classifying interpersonal verbs: stimulus, experiencer, agent, and patient. Based on semantic roles, Brown & Fish classified three types of interpersonal verbs: stimulus-experiencer verbs (e.g., impress), experiencer-stimulus verbs (e.g., like), and agent-patient verbs (e.g., touch).

In sentences with state verbs, the subject and object of the sentences take the role of stimulus or the role of experiencer, and we usually attributed to the stimulus. That is, sentences with experiencer-stimulus verbs, such as John likes Mary, show NP2 bias, and sentences with stimulus-experiencer verbs, such as John impresses Mary, show NP1 bias. People's pattern of attribution with state verbs well accords with Brown & Fish (1983)'s classification of stimulus-experiencer verbs and experiencer-stimulus verbs (Rudolph & Försterling, 1997).

In sentences with action verbs, such as *John touches Mary*, Brown & Fish (1983) used semantic roles of agent and patient and classified such verbs as agent-patient verbs. Unlike state verbs, in sentences with action verbs, a constituent that takes the role of agent is usually placed as a subject of the sentence, and we usually attributed to the agent. However, people's pattern of attribution with agent-patient verbs was not always in accord with Brown & Fish (1983)'s classification (Rudolph & Försterling, 1997).

However, people attribute to the object of a sentence in some sentences with action verbs, such as *John criticizes Mary*. For this sentence, many people attributed to Mary's behavior or personality. That is, John's action is a reaction to Mary's behavior or personality. To solve this problem, Rudolph & Försterling (1997) added agent-evocator verbs to Brown & Fish(1983)'s distinction. They further proposed that in sentences with agent-evocator verbs, cause is attributed to the object of the sentence.

One thing that has to be made clear is the fact that even though Rudolph & Försterling (1997)'s classification has been most widely referred, a large variation in the strength of IC bias depending on the verbs had been reported. Some verbs show very strong bias, such as showing the bias more than 90% of the times. However, some verbs showed very weak bias. To explain the variation in the strength of IC bias, some psychologists proposed finer-grained semantic analysis of interpersonal verbs (Hartshone & Snedecker, 2013).

The Cause of Implicit Causality Bias

Even though there is a large variation in the strength of IC bias depending on the verbs, the reason why IC bias shows the pattern as a function of verb types needs to be explained. That is, we need to figure out some inherent reasons why state verbs, stimulus-experiencer verbs and experiencer-stimulus verbs, show bias toward the stimulus NPs, and why action verbs, specifically agent-evocator verbs, show bias toward the evocator NPs.

Concerning the causes for the IC bias, Bott & Solstad (2014) and Solstad & Bott (2017) proposed in their semantic theory of causal discourse that IC bias follows from a general processing preference not leaving "missing content" unspecified. That is, explanation is more likely to be about the missing content. In addition, they proposed that a specific constituent is more likely to be the missing constituent for each type of interpersonal verbs. That is, for state verbs, properties related with the stimulus is more likely to be the missing constituent, and for agent-evocator verbs, properties related with the evocator is more likely to be the missing constituent.

In addition, Bott & Solstad (2014) proposed three kinds of explanation relations: simple cause, externally anchored reason, and internally anchored reason. Simple causes are supposed to be causes of events, states, or mental states. "*John disturbed Mary because he was making lots of noises*" is an example of simple cause. Simple causes never involve volition or agentivity on the side of the individual doing the simple causes. In the "*John disturbed Mary …* " sentence, John did not intend to annoy Mary when he made noises. That is, the simple cause is associated with stimulus, not experiencer. Externally anchored reasons and internally anchored reasons are causes of attitudinal states. Externally anchored reasons are causes which are external to the attitude-bearer's, i.e., agent's, mind. "*John disturbed Mary because she had damaged his bike*" is an example of externally anchored reasons. In the sentence, Mary's behavior causes John to do something that disturbs Mary. Therefore, the externally anchored reason is associated with NP2 bias. On the

other hand, internally anchored reasons designate causes which are internal to the attitude-bearer's mind. "*John disturbed Mary because he was very angry at her*" is an example of internally anchored reasons. In the sentence, John's anger caused him do something that disturbs Mary. The internally anchored reason is associated with NP1 bias.

It has been reported that there is some relationship between verb types and the kinds of explanations people prefer. In sentences with state verbs, simple cause is more likely to be triggered as explanation, and the properties of the stimulus will be the subject of the *because* clause. Therefore, stimulus-experiencer verbs show NP1 bias, and experiencer-stimulus verbs show NP2 bias. In sentences with agent-evocator verbs, external reason is more likely to be triggered as explanation, and show NP2 bias. The situation is complicated with the agent-patient verbs. In sentences with agent-patient verbs, external or internal reason is more preferred to simple cause. However, which reason, external or internal, is preferred varies depending on the verbs.

Two Modes of Processing Implicit Causality

In the previous section, discussion on causal attribution has been focused on the semantics of interpersonal verbs. However, when we try to explain some events, such as *John fascinated Mary*, we take many factors into account. For instance, gender, social status, and typical thematic roles expected from the social relations of the noun pairs (e.g., teacher – student) can affect the causal interpretation of the sentence (Corrigan, 1988). Factors that affect causal attribution can be classified into two types: lexical-semantic information and world knowledge.

Lexical-semantic information refers to the information which is included in the verb, such as implicit causality. Factors beyond the level of lexical semantic information of verbs, such as gender, social status, and the discourse context, are classified as world knowledge. As two types of factors affect the causal attribution process, we can ask questions such as what the role of each factor is, when and how the two factors affect the causal attribution, and whether the two factors interact etc. In this section, time course of the use of interpersonal verbs on causal attribution will be covered to explore the possibility of two processing stages account of causal interpretation of sentences. The two stages account gets supported if a semi-autonomous processing based on lexical information is verified.

Let's consider the time course of the use of lexical information of verbs on causal attribution. In many papers on the time course of the use of interpersonal verbs, focusing model and integration model were usually considered (Solstad & Bott,

2017). The two models differ in when the semantic information of verbs begins to be used. The focusing models assume that the semantic information of verbs is used as soon as possible to form the initial interpretation of the event. That is, we form initial situation model from the semantic information of verbs. In fact, Ferretti, McRae, and Hatherell (2001) had proposed that verbs activate related semantic roles to help build situation models as soon as possible. Let's consider a sentence such as

Betty scolded Diane *because* she didn't clear her room.

Here the main clause describes an event, and the subordinate, *because*, clause offers a reason for the event. According to the focusing model, as the verb *scold* is an agent-evocative verb, the semantic information of verb *scold* predisposes the participants expect Diane as a subject of *because* clause. We can test the focusing model by comparing reading time of congruent *because* clause (e.g., because she didn't clear her room) with that of the incongruent *because* clause (e.g., because he was very angry at the moment). If the focusing model is right, we have to change our interpretation in the incongruent condition. That is, reading time of *because* clause, especially that of the first NP that follows *because*, for the congruent version should be shorter than that of the incongruent version. This effect is usually called the congruence effect. The focusing model is theoretically very similar to the garden path models of syntactic processing (Frazier & Fodor, 1978).

The integration models, on the other hand, assume that the semantic information of the verbs is used when we try to integrate information after the ambiguity in *because* clause is resolved. Therefore, we do not expect the congruence effect if the integration model is right. Reading time of *because* clause, especially that of the first NP that follows *because*, in the incongruent condition does not need to be longer than that of the congruent condition.

Early studies on the interpretation bias seemed to support the integration model. The problem with most of the early studies is the fact that offline tasks such as sentence completion or causal attribution tasks were mainly used. However, when on-line tasks, such as self-paced reading time (Koornneef & Van Berkum, 2006), event-related potential (Pyykk¨onen & J¨arvikivi, 2010), and visual world paradigm (Cozijn, Commandeur, Vonk, & Noordman, 2011) were used, results supported the focusing models more often than the integration models.

Second factor that has to be investigated is the time course of the use of world knowledge on causal attribution. We can test the effect of world knowledge by comparing the condition where the causal explanation based on world knowledge matches that of the lexical bias of the verb (match condition) with a condition where the causal explanation based on the world knowledge leads to a different attribution

from that of the verb bias (mismatch condition). If the world knowledge is used from the beginning, reading time of the match condition should be faster than that of the mismatch condition in the early part of the *because* clause. On the other hand, if the world knowledge is used at the integration stage, reading time of the match condition should not be different from that of the mismatch condition in the early part of the *because* clause, but reading time of the match condition should be faster than that of the mismatch condition in later part of the *because* clause.

As in studies on the time course of the use of lexical information of verbs on causal attribution, early studies on the use of world knowledge had used off line tasks and showed that world knowledge also affects the causal attribution. However, there has been little research on the time course of the use of world knowledge. Park & Do (2017) had investigated the time course of the effect of lexical information and that of the world knowledge in an experiment.

Park & Do (2017) conducted an experiment that has manipulated the social relations of two nouns in a sentence in which experiencer- stimulus interpersonal verb is used (e.g., *The teacher respected the student, because the student works hard* vs. *The student respected the teacher, because the teacher works hard*.). The two examples were congruent with IC bias, but only the second one was normal in terms of social relationship of the two nouns with respect to the verbs (match condition). In the experiment, participants read each sentence word by word, and rated the appropriateness of the explanation given in *because* clause after they finished reading the whole sentence. In the experiment, the pattern of causal attribution as well as that of reading time showed that the type of explanation seems to be determined more by the type of interpersonal verbs than the roles expected from the social relations of the two NPs of the pair, even though the latter also affected which type of explanation is produced. In addition, reading time of NP that follows *because* in *because* clause is shorter in the congruent condition than in the incongruent condition, but not different between the match and mismatch condition. However, reading time of the remaining part of *because* clause is shorter in the match condition than the mismatch condition, but not different between the congruent and incongruent condition. The results were interpreted as supporting the two processing stages account. That is, initial processing of a sentence based on verb is followed by a deliberate processing of the sentence which takes more factors such as roles expected from the social relations of the noun pairs into account.

THE LEXICAL BASIS OF EXPLANATION TYPE PREFERENCE

We are very good at evaluating the relevance and the quality of explanations given for events and objects. As most of the explanation we encounter in everyday settings belongs to why explanation or how explanation, the fact that we are good at evaluating the relevance of the explanation suggests that there might be some cues that signal which type of explanation is adequate. However, the question how people choose between the two explanation types has not been covered in the previous section. In the previous section, lexical basis of causal attribution has been explored in studies that use minimal sentences. Results of studies on IC bias showed that semantic information in the verbs induces certain type of explanation more likely than other types. However, as there is very little information other than the relative position of the two NPs in the minimal sentences, we can test which NP, subject NP or object NP, is used as a subject of *because* clause. In this section, how people choose between the two types of explanations, how explanation and why explanation, will be covered. This section consists of two subsections. In the first subsection, basic issues related with explanation and explanation type preference will be covered. In the second subsection, a proposal for the lexical basis of explanation type preference will be described.

Explanation and Explanation Type

Children ask many questions. They start to ask simple what questions, such as what is this, but as they get older, they ask why or how questions more often than what questions. The changes in questions over development suggest that we need to understand more about the objects, people, or events to answer why or how questions. And it happens that many of the answers to the why or how questions take the form of explanation. The fact that even young children ask reasons for the answer suggests that explanations have some functions for our intellectual needs. In this subsection, basic issues related with explanation and explanation type preference will be covered.

Functions of Explanation

Keil(2006) proposed a number of functions explanations can have. Here, I will list a few functions of explanation. The most prominent function is that explanation helps understanding and prediction. For instance, when we get the explanation that we had many traffic accidents last night because of the poor visibility due to high level of humidity, we not only understand why it happened, but also use the information in future occasions of similar weather. We will be more careful in driving. Explanation also helps learning concepts (Williams & Lombrozo, 2010).

Explanations help diagnosis. We can predict the state of one event from that of the other event when the two events are correlated, but cannot infer causality only with information about correlation. However, if we have explanations for the correlation, we can infer causality and use the information for diagnosis.

Explanations also help assign blame for one-time events, such as having a car accident last night. Different from events that happen repeatedly, we cannot use information about correlation or contingency for one-time events. Therefore, explanation exerts more influence in understanding the cause of one-time events than events that happen repeatedly. We affix blame to the party causally related with the one-time events. Likewise, we use explanation to justify an action.

Explanation Type

The next question we can raise concerning explanation is whether there is just one type of explanation or a number of types of explanation. Many explanations we encounter belong to one of the two types, why explanation and how explanation (Lombrozo & Wilkenfeld, forthcoming). Why explanation is also called as teleological explanations. As the word teleological implies, why explanation is explanation based on the goals, purposes, or the functions of the objects, people, or events. "The tree is tall for birds to make nests," and "The smartphones have keypads for people to enter phone numbers" are examples of why explanations. How explanation, on the other hand, is also called as mechanistic explanation. As the word mechanistic implies, how explanation is based on the parts, processes, and proximate causal mechanism.

Lombrozo & Wilkenfeld (forthcoming) argued that the two types differ in several aspects. The two are different in temporal directionality. Why explanation is future looking because it explains based on the goals, i.e., what it is for. On the other hand, how explanation is backward looking because it explains in terms of mechanism, i.e., how it comes the way it is. The two also differ in the directness of causality. How explanation invokes proximate causes directly. Why explanation, on the other hand, does not invoke proximate causes. As goals can be achieved in a number of ways, it indirectly invokes proximate causes. In addition, Lombrozo & Wilkenfeld (forthcoming) proposed that why explanation works as default explanation type. The last point leads to the question whether some explanation type is preferred to others, i.e., explanation type preference.

Explanation Type Preference

The discussion over explanation type preference can be approached in two ways. It can be approached by tracing the changes in preference in terms of age, domain, expertise, and processing demand. It can also be approached by searching the determinants of the preference.

Let's briefly review studies that reported changes in explanation type preference. As young children are eager to look for and evaluate explanation, developmental psychologists have investigated the type of explanation children and adults generated (Keil, 1992, Keleman, 1999a, 1999b, 2003). If the two explanation types demand about equal amount of cognitive resources, there may not be a consistent developmental trend between the two types. On the other hand, if the two types demand different amount of resources, then the type that require less resources is likely to be used as default explanation type.

Of the two explanation types, why explanation seems demand less resources than how explanation. We simply need to think about the goals or the purposes of the agent to generate why explanation. However, we have to think about the processes involved and the possible mechanisms that links the processes to make how explanation. For this reason, we hypothesize that why explanation work as default explanation type. In fact, Keleman (1999a, 1999b) showed that young children produced mostly why explanations, and proposed that why explanation is default explanation type.

Once why explanation is identified as default explanation type, the next step is finding when or under what circumstances how explanation starts to be produced or rated as adequate explanation. Results of previous studies suggested that age, domain of the target of the explanation, expertise, and processing demand seem to work as modulating factors. Let's look at some results that showed changes in explanation type preference. The first factor is age. As children get older, their cognitive capacity increases so that they can handle cognitive processes which demand more resources. In addition, their knowledge also gets more differentiated so they can figure out which type of explanation is more adequate for a question. Compared to young children who generated mostly why explanations, adults generated how explanations as well as why explanations (Keil, 1992; Kelelman, Rottmman, & Seston (2013). However, psychologists reported different results whether young elementary school children could generate how explanation. Keleman(1999a, 1999b) reported that young elementary school children generated mostly why explanations. However, Keil(1992) reported that elementary school children generated different types of explanation depending on the target of the explanation (explanandum). Keil(1992) reported that elementary school children generated why explanation to biological objects, and how explanations to nonbiological objects, such as natural phenomenon.

The domain of the target of explanation also affects which type of explanation is generated or preferred. Keil (1992) proposed that why explanation is preferred when the explanadum is artifacts (e.g., telephone), or body parts of biological objects (e.g., hands). On the other hand, how explanation is preferred when the explanadum is biological objects (e.g., tress), or non-biological objects (e.g., weather).

The third factor is expertise and processing demand. Kelelman, Rottmman, & Seston (2013) asked experts of natural science to judge the truth of a given explanation. Experts rated why explanation less favorably under normal condition. However, when they were tested under time pressure, even experts rated the why question more favorably.

Lexical Basis of Explanation Type Preference

As people showed explanation type preference, we need to figure out the determinants of the explanation type preference. Even though there has been little research on the issue, two candidates have been proposed. The first candidate is the domain of the explanandum. Keil (1992) classified objects into artifacts, biological objects, and natural phenomena, and proposed that the most important property for each category is different. The most important property for the domain of artifacts is function. Let's think about telephone. Telephone is for communication. How the telephone works or what parts comprise a telephone seems less important. When the explanation is about nonbiological objects, such as weather, adults prefer how explanation. However, the situation is a little more complicated with biological objects. Adults preferred how explanations when explanation is about biological objects, and why explanations when the explanation is about the body parts of biological objects, such as hands. Even though domain of explanandum can work as a primitive guideline in determining the explanation type, Yoo & Do(2016) reported cases where people prefer explanation type different from the guideline.

The second candidate is the verb of the explanandum. This idea has not been formally presented in studies on explanation yet. However, the importance of verbs on explanation type preference has been suggested in Lombrozo & Carey (2006) and Ojalehto,Waxman, & Medin (2013). In both studies, the authors emphasized that the interaction between the subject and verb of the explanandum is crucial in determining the explanation type. Ojalehto et al.(2013), in particular, proposed that a relational perspective formed by the combination of the subject and the verb of the explanandum is the key components in determining the type of explanation. However, Ojalehto et al.(2013)'s idea has some problem. It seems to take much time.

To get the relational perspective, we have to do two things in sequence. First, we have to identify two components of the explanation, subject and verb. Then we have to form integrated models that can be formed with the two components. However, Ojalehto et al.(2013)'s idea shed light on the importance of verbs in determining the explanation type.

The idea about the relationship between verb types and the explanation type can be found in Bott & Solstad (2014). Bott & Solstad (2014) suggested that state verbs trigger simple cause as explanation, which is similar to how explanation, and action verbs trigger external or internal reason as explanation, which is similar to why explanation. Based on Ojalehto et al (2013) and Bott & Solstad (2014), I propose that the verb types induce one type of explanation more plausible than the other type of explanation. More specifically, I propose that how explanation is preferred if verb of the explanandum is state verb, and why explanation is preferred if verb of the explanandum is action verb (verb cue hypothesis of explanation type preference).

Results of Yoo & Do (2016)'s study corroborated the verb cue hypothesis of explanation type preference. In the experiment, participants read two sentences: The explanandum is described in the first sentence (e.g., The cloth is completely dry), and why or how explanation for the first sentence is presented as the second sentence. After participants read the two sentences, they were asked to judge the appropriateness of the explanations given in the second sentence. Participants' explanation type preference was mostly determined by the type of verbs: When the predicate was a state verb, how explanation was preferred. However, when the predicate was an action verb, why explanation and how explanation were preferred almost equally. The pattern is very similar to that of IC bias with interpersonal verbs. IC bias is strong with state verbs, but not strong with action verbs, especially with agent-patient verbs (Rudolph & Försterling, 1997). Though the time course of the explanation type preference has not been investigated yet, results of Yoo & Do (2016)'s experiment can be interpreted as giving preliminary support for the two processing stages account.

SOLUTIONS AND RECOMMENDATIONS

The verb cue hypothesis, and the two stages account have been proposed to explain people's ability to generate and evaluate the quality of explanation. The verb cue hypothesis can be applied in educational settings. Keleman (1999a, 199b, 2003) reported that children made why explanation almost all time and they started to make

how explanation as they grew older. If we can teach children pay attention to the semantics of the verb before making explanation, it would reduce the number of why explanations. In addition, the two stages account can be applied in designing interfaces of decision support system to reduce making premature decisions. Keleman et al. (2013) reported that even experts rated why explanation more favorably when they were asked to judge the quality of explanation under time pressure. We can reduce making premature decision either by setting inactive period before making decision or educating people be aware of the lexical basis of explanation type preference.

FUTURE RESEARCH DIRECTIONS

Though we need further empirical studies to validate the verb cue hypothesis, I raise three points for future research. First, we need to test the hypothesis across languages. Even though the implicit causality bias had been reported across languages (Bott & Solstad, 2014; Goikoetxea, Pascual, & Acha, 2008; Rudolph & Försterling, 1997), the time course of the IC bias had received little attention in languages other than English. Verb cue hypothesis seems plausible in languages, such as English, in which verb comes before objects, because listeners/readers can assign thematic roles before they read the object. However, verb cue hypothesis may not be an attractive idea for languages, such as Japanese and Korean, in which verb comes after objects. Studies with different languages using on-line tasks need to be conducted.

Second, it seems that we need much semantic knowledge about verbs to use verb cues. Developmental studies need to be conducted to investigate when children start to use verb cue hypothesis using verbs that have various degree of semantic complexity.

Third, as we live in a world where many things happen simultaneously, the two processing stages account of causal attribution and explanation seems quite attractive, like many dual processing models. For the two stages account to be a plausible model, the first stage needs to be verified as default mode of processing. That is, the semi-autonomous processing stage which is primarily dependent on the lexical information of verb has to be tested effective even under time pressure in the future study.

CONCLUSION

When we encounter people, objects, or events that we do not expect, we try to understand what they are. If we could not find the answer for ourselves, we rely on others for the answer and sometimes the reasons why the answer is right. As explanation is supposed to fill the epistemic gap (Grimm, 2008; Sintonen, 1989), we also have to identify what are possible candidates (van Frassen, 1980). However, it has been found that we are very good at evaluating the relevance and quality of explanation. To accomplish this amazing achievement, we need to quickly identify which type of explanation is needed. In this chapter, I propose verb cue hypothesis and two stages account to explain how we so easily identify which type of explanation is needed in the situation.

The verb cue hypothesis has been discussed with studies on causal attribution and explanation. In studies on causal attribution using minimal sentences, it has been reported that verb types seem to induce some type of explanation (e.g., NP1 bias) more likely than other type (e.g., NP2 bias) (Bott & Solstad, 2014; Hartshone & Snedecker, 2013; Rudolph & Försterling, 1997). The situation is quite different with studies on explanation. As many factors were included in the material we used in studies on explanation, explanation has been supposed to be the product of deliberative processes. However, it has been reported that we are good at evaluating the quality of explanations (Cimpian, 2015). It seems that we need a shortcut to be able to evaluate explanation easily.

In this chapter, I propose a two processing stages account for causal attribution and explanation to explain how we can easily evaluate explanation: A semi-autonomous processing stage which is primarily dependent on the lexical information, and a deliberate processing stage that takes many factors into account. I also propose verb cue hypothesis of explanation as a plausible means for the semi-autonomous processing stage of the two stages account. Based on Bott & Solstad (2014)'s model of causal attribution of interpersonal verbs and Ojalehto et al. (2013)'s idea of relevance framework of explanation, I propose that the verb of explanandum induce a certain type of explanation more likely than the other type. More specifically, how explanation is supposed to be preferred when the verb is state verbs, and why explanation is preferred when the verb is action verb.

The verb cue hypothesis gets empirical support from previous studies in causal attribution and explanation type preference. Causal attribution studies that used interpersonal verbs showed that pronouns that match its prediction are processed faster than pronouns that did not match. In addition, people prefer making causal

attribution that matches implicit causality bias in sentence continuation studies. In explanation type preference studies, people judge explanations that match the prediction based on verb cue hypothesis better than explanations that did not match especially when the verbs re state verbs. Possible applications and recommendation for future research were also considered.

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KEY TERMS AND DEFINITIONS

Causal Attribution: Mental process that tries to determine the cause of an event. Traditionally, the cause is attributed to a person or a situation.

Explanation Type Preference: Preference toward one type of explanation over the other type.

How Explanation: Explanation that is focused on the mechanistic cause of an event.

Implicit Causality: Causality that is assumed to be included in the meaning of the verb.

Implicit Causality Bias: Bias of choosing the subject of explanation depending on the implicit bias of the verb.

Semantic Role: Role of a constituent of a sentence that is determined by the verb.

Why Explanation: Explanation that is focused on the goal or purpose of an agent or an object.

Chapter 7
Laugh and Laughter as Adaptation in Human Being: Past and Present

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ABSTRACT

In the process of human evolution, the biggest adaptive problems have been how to maintain a group and how to rise in rank in a group hierarchy. If an adaptive problem is solved, the probability the solver will survive and success in reproduction rises. Laugh and laughter is discussed in the frame that it has been used to solve the adaptive problem in this chapter. The trigger of laughter is the cognition of a discrepancy. The discrepancy is the difference between what is expected and the actual state. A discrepancy cannot be serious to cause laugh and laughter. If it is implicitly expected to be resolved, then it is likely to arise a laughter with positive feeling. When laughter is shared by some people, it functions to link them with friendly relationship. On the other hand, the laughter becomes derisive (ridicule) when the discrepancy is between a social norm and an actual behavior. The ridicule functions to one's supremacy over the target individual. This function has been adaptive in the society of dominance hierarchy.

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INTRODUCTION

In the process of human evolution as a species of social mammals, the biggest adaptive problems have been how to maintain their group and to rise in rank in their group hierarchy. Solving an adaptive problem raises the probability to survive and succeed in reproduction. In this chapter, humor and laughter is discussed in the context of social adaptation. Laughter is triggered by the detection of a discrepancy. A discrepancy is the difference between what is predicted and/or expected and the actual state. A discrepancy cannot be serious to cause laugh and laughter. If it is implicitly expected to be resolved, then it is likely to give rise to laughter with a positive feeling. When laughter is shared by a group of people, it functions to connect people and foster friendly relationships. When the prediction is based on scientific knowledge, intellectual curiosity is usually aroused by the discrepancy. On the other hand, the laughter becomes derisive (ridicule or mocking) when the discrepancy is between a social norm and an actual behavior. The ridicule functions to establish one's supremacy over the target individual. This function has been adaptive in the society of dominance hierarchy. It is because if one ridicules the target individual, it implies that he or she is superior to the target individual. In this sense, a self-deprecating laugh or humor is more likely to be accepted by others because it means that the laugher has no ambition to be superior to others.

ADAPTIVE PROBLEMS OF SOCIAL ANIMALS

Homo sapiens are primates, and thus have evolved as a social mammal. There are two kinds of benefits of grouping for adaptation. The first is that it becomes easier for animals to protect themselves, not only from predators, but also from other groups of the same species. For example, muskoxen are known for their clever defense against wolves or other predators. When they see predators, muskoxen run together for circle defensive formation so that they all try to face the threatening predators. Predators cannot attack them because of the risk to be injured by their big horn. Another example is that of chimpanzees making an extra effort to warn group members that seem ignorant of danger. The more the group members, the more likely they detect a predator. Generally, bigger groups have an advantage not only in defense against predators, but also in the conflict against human enemies. Out-group members are potential or actual rivals of a group, because they compete for the same resources in the hunter-gather society. Hence, smaller groups have been less likely to survive in the history of evolution.

The second benefit is that grouping makes it possible to do what an individual cannot do alone. For example, it is more beneficial and effective to hunt in a group than to hunt alone, as shown in the example of mammoth hunters. Furthermore, after the Cultural Big Bang about 50,000 years ago, the bigger the social groups, the more effectively cultural products, resulting from cultural and scientific innovations, are transmitted to each other. These are expected to cause social and scientific development. After coexisting with Homo sapiens, Neanderthals became extinct about 30,000 years ago in Europe. The reason for this was thought to be the intellectual inferiority of Neanderthals, but it is now believed to be because of their small group size (e.g., Shipman, 2015). The development of new hunting technologies among the Homo sapiens was enhanced through mutual interaction within their large social groups. This was of greater advantage for them to get resources in the Ice Age Europe. On the contrary, the Neanderthals' lack of ability to develop such hunting technology led to their extinction.

However, the costs of maintaining a big group are high. The group has to maintain harmony so that the group members do not fight each other and the group is divided into a few smaller groups. Members have to understand each other in order to maintain their group. When a group consists of only two individuals, it is only one whom each member has to understand. When the group has three individuals, each member needs not only to understand the other two individuals, but also the relationship between the two, as this is important to keep the group together. In this way, the number of inferences increases exponentially with the number of group members.

Homo sapiens have taken two evolutionary strategies to solve this adaptive problem. The first is mindreading, also called theory of mind. Theory of mind (ToM) is an ability to attribute other's behavior to his or her mental states: beliefs, intents, desires, emotions, and knowledge (Baron-Cohen, 1995). The term "theory" means that people have a theory to explain other's behavior supposing that humans have a "mind." This has made it possible for Homo sapiens to have mutual understanding, and thus helps them to maintain group harmony.

The second strategy is the growth of cognitive capacity which is biologically supported by the neo-cortex. As mentioned, the more the group members, the more the cognitive processing to understand the relations among members. Dunbar (1996) was able to show an association between the size ratio of the neo-cortex to the brain and social group size among living primates. According to his data, the number of group members is about two in prosimian, about two to four in Macaca, about 10 to 20 in gorilla and chimpanzee. According to this rule of the proportion of the neo-cortex, the optimal group size for Homo sapiens is about 150. People in the contemporary world may have many more acquaintances but the number of persons each individual interacts with to some extent at a certain point of time may be around 150.

However, Homo sapiens can construct big organizations such as companies, political parties, governments, and nations, beyond the number of 150. What makes it possible for humans to construct these big organizations are language, religion, institutions such as the legal system, and laughter, which is the topic of this chapter. Dunbar (1996, 2014) proposed that one of the most frequent ways by which chimpanzees make interpersonal relationships stronger is grooming. It seems to be very comfortable for chimpanzees to be groomed by other individuals. This reciprocity is important to keep friendly relationships between individuals. The one which is groomed by another individual grooms it in return. This reciprocity of grooming is effective to enhance the friendly relationships between individuals and thus to keep the group harmony. However, its demerit is that it takes too long.

The "time budget mode" theory that Dunbar (2014) proposes that one of the biggest problems for each species of animal is how each individual invests time for many kinds of behaviors: Foraging, eating, sleeping, mating, fostering, etc. Primates as a social mammal have to invest time for keeping good relationships with their group members. But, it is not adaptive to take too long time for reciprocal grooming, because they also need the time for foraging and many kinds of behaviors.

According to Dunbar (2014), language evolved so that this adaptive problem could be overcome. Language is a much more effective way for Homo sapiens to communicate their friendly will to others through mindreading. Another instrument to build stronger relationships among group members is religion. Despite the many hypotheses about the origin of religion, most researchers agree that religion, with its function of organizing a group, brought adaptive advantage to the evolution of Homo sapiens (e.g., Wade, 2009). For example, a religion that encourages people to worship the spirit of their ancestors makes it possible to organize them into a tight-knit group. In another case, a shaman, who is believed to transmit the message of god, can employ trance-inducing techniques with music and dance, to incite many people to have visionary ecstasy, and to provide people a sense of togetherness.

Like religion, to laugh together also makes people experience a sense of togetherness (e.g., Curseu & Fodor, 2016; Fine & De Soucey, 2005). For example, when you laugh at a comedy with your friends, it makes your relationship with your friends better. However, laughter is different from religion in the sense that it needs a target or a victim. If the target of the laughter with your friends is your group member and your laughter is regarded as a ridicule laugh or mocking laugh, it is possible that the target becomes degraded in the group. Otherwise, it is possible that the target comes to refuse his or her good friendly relationships with you.

LAUGH AND LAUGHTER IN THE FRAME OF DUAL PROCESS THEORY

Dual process theorists (Evans, 2010; Stanovich, 2009) propose two kinds of subsystems, one of which processes heuristic thought and the other which processes analytic thought. The former is called System 1 and the latter System 2. Most dual process theorists agree that the distinction between the two subsystems is in their cognitive capacity. The processing of System 1 does not require large cognitive capacity, whereas System 2 does. The characteristics of each system are shown in Table 1.

Stanovich (2004) called System 1 the autonomous set of systems (TASS), because it consists of a set of modules. He described System 1 with a metaphor used by evolutionary psychologists that the mind is like a Swiss army knife (Tooby & Cosmides, 1992). A Swiss army knife is useful in so many situations because it has a large number of components (bottle opener, knife, toothpick, cork-screw, and so on) each of which is well designed for solving a specific problem. Each component corresponds to a module. The term "module" was introduced by Fodor (1983), who made a distinction between modular processes (System 1) and central processes (System 2). Fodor's characterization of a module was that it is innate, fast, domain-specific, and informationally encapsulated, with particular inputs and shallow output. If an input process is encapsulated and modular, the information in this process is not affected by a person's beliefs. Therefore, it is adaptive in saving limited capacity and in describing the world adequately without interference of

Table 1. The contrast between System 1 and System 2.

System 2	**System 1**	
Evolved only in humans	Evolved as a social mammal	Evolved for adaptive responses to natural environment
General system	Social exchange module Theory of mind module	Naïve physics module Naïve biology module
Features of Cognitive Processing		
High capacity demand Rule-based Analytic Sequential Controlled Relatively slow Domain-general Normative rationality	Low capacity demand Associative Holistic Parallel Automatic Relatively fast Domain-specific Evolutional rationality	

beliefs. According to Fodor, input processes are modular, and the information that is sent from these processes to a central process is used in constructing a belief. The "module" can be interpreted as a unit of functioning and adaptive processing; thus, it is directly shaped by natural selection.

Several modules have been proposed, which can be grouped into two. The first group is assumed to have evolved in response to the natural environment. The second group is inferred to have evolved as social mammal-like primates (e.g., Cummins, 1998). Two typical modules of the first group are listed in Table 1. The naïve physics module is innate and responds to basic physical phenomena such as free fall and bounce of object and gives an intuitive understanding for these (Spelke, 1988). The term "naïve" means that people (laypersons) do not have specialist knowledge on physics but they intuitively understand everyday physical phenomena. The naïve biology module corresponds to our understanding of biological phenomena (Keil, 1989). For example, even a very young child can understand the distinction between dead and alive objects and knows that the dead cannot return to life.

Two important modules are picked up from the second group in this chapter. The ToM module is already mentioned in the former section. This evolved in the environment of social interaction (e.g., Baron-Cohen, 1995; Leslie, 1992).The ToM module makes it possible for each individual to explain others' behavior in terms of their mind, and is the basis for mindreading. However, the ToM subsystem actually works with the cognitive capacity of System 2 in the real world (e.g., Carlson, Moses, & Claxton, 2004). The executive function of System 2 helps ToM work adaptively in the contemporary world. A social exchange helps people not only in the sense that the exchange itself makes their relationships stronger, as in mutual grooming, but also in the sense that it enhances the division of labor. One of the primitive styles of division of labor is a barter trade. If each individual produces what he or she is good at making and barter for surplus, production is efficient. The social exchange module, which is thought to have evolved through social interaction, is triggered when individuals are in social transaction. A significant adaptive problem is how individuals are not cheated by the other party in this transaction. Hence, the module is sensitive to possible cheating (e.g., Cosmides, 1989).

There are other modules which are not presented in this chapter. Each module functions like one of the blades of a Swiss army knife. This idea is summarized as the massive modularity hypothesis, proposed by evolutionary psychologists, which says that the human mind consists of many modules (Tooby & Cosmides, 1992; Sperber, 1994). However, dual process theorists hypothesize that System 2 controls the modules as a general-purpose system (Evans, 2010; Stanovich, 2009).

Is there a "laugh" module in the human mind then? No psychologists have proposed this module up to the present time. Laugh or laughter can be initiated by the recognition of a discrepancy (Deckers & Kizer, 1973; McGhee, 1979), but it is not only laugh or laughter that is caused by this recognition. Hence the process from the recognition of a discrepancy to the response of laugh or laughter is not modular. Rather, the most typical response to a discrepancy is curiosity. Curiosity arises automatically; hence this may be called the "curiosity" module. However, its modularity is weak, as it is not this module but a different one that detects a discrepancy. For example, the discrepancy of a strange motion of a ball with the law of free fall is detected by the naïve physics module. This detection creates a curiosity to know why. If the ball moves like an animal and if you are watching the motion with your friend, you may laugh at the motion with your friend. However, whether you laugh or not depends upon the context. Laugh or laughter is not modular in this sense.

The assumption that the trigger of laughter is the detection of discrepancy is also confirmed by studies of primates. For example, in their view of evolution, Gervais and Wilson (2005) pointed out that a discrepancy is likely to triggers primates' facial muscle movement of pleasure, called the Duchenne display.

SOCIAL FUNCTIONS OF LAUGH AND LAUGHTER

What are the conditions for whether the detection of a discrepancy causes curiosity and/or laughter? Table 2 shows the classification of responses after the detection of a discrepancy. When the target is a human, one of the important features of laugh or laughter is that this has a function of making human relationships stronger (e.g., Curseu & Fodor, 2016; Fine & De Soucey, 2005). The process from detection to laughter includes mindreading of the people who are expected to detect the discrepancy of a target and to laugh together. For example, when you watch a performance of a comedian, detect a discrepancy between his movement and what people usually make and, find that his performance is funny, and realize through mindreading that almost all of the audience thinks that his performance is funny, you may want to laugh at the performance and expect most of the audience to laugh as you do. This is contagious laughter (Martine & Gray, 1996; Provine, 1992). This shared laughter is very likely to build a harmonious relationship between the members of the audience. Therefore, it is an important factor whether you detect a discrepancy alone, or with others to whom your laugh or laughter is infectious. Furthermore, if you and the audience feel negatively towards the comedian, you may have a mocking laugh at him.

Table 2. The classification of responses to a discrepancy.

Target	Situation	Valence	Response
Human	Alone	Positive	Affective worry Laughing with the target
		Negative	Disguise
	Infection	Positive	Shared affective laughter
		Negative	Shared laughter of ridicule
Man-made object (artifact)	Alone	Positive	Affective curiosity
		Negative	Disguised curiosity
	Infection	Positive	Shared laughter
		Negative	Shared laughter of ridicule
Object of animistic projection	Alone	Positive	Affective curiosity
		Negative	Disguised curiosity
	Infection	Positive	Shared laughter
		Negative	Shared disguised curiosity
Physical object	Alone	Positive	Curiosity
		Negative	Disguised curiosity
	Infection	Positive	Shared curiosity
		Negative	Shared disguised curiosity

Mindreading is applied not only to those who detect the same discrepancy, but also to the individual (target) who causes a discrepancy in some cases. For example, when you find that your friend leaves his zipper down, you may laugh at him. Your laughter indicates to him that something is wrong, and he may notice his error. Then he may laugh at his blunder (discrepancy), and you and your friend laugh together. It is likely that this makes the friendship between you and your friend stronger. However, this is the case only if you and your friend are on good terms. If not, he is likely to feel insulted by your laugh and get angry. Therefore, it is an important factor whether the target has positive or negative relationships with you.

Some discrepancies evoke the emotion of anger. A typical discrepancy which the social exchange module detects is the consequence that a receiver gives nothing in return for what he or she is given. It is cheating, in short. It is very likely that this discrepancy, recognized by the cheater-detection device in the social exchange module, evokes anger in the cheated individual (Cosmides, 1989). However, it is also

possible that the receiver accidentally forgets giving something back. For example, your friend may accidentally not give you a present on your birthday although you gave him a gift for his. He forgot your birthday. However, if neither you nor your friend wishes to end the relationship between you, you may laugh and forgive him, accepting his apology, because his mistake is attributed to his forgetful nature. Your laughter shows that you are not angry with him. This is another example for laughter preserving group harmony.

Although the origin of laugh and/or laughter lie in the process of human or primate evolution, humans use it differently according to the situation. These differences are shown in Table 2. Besides humans, three other kinds of targets may be added: man-made objects (artifact), objects of animistic projection such as a doll, and physical objects. The case where the target is human has already been discussed above. If the target is a man-made object, people's responses are very similar to those when the target is human. People may read the intention of the creator who made it and if they find a discrepancy in it with their friends, they may laugh at the object and/or its creator with their friends. If the discrepancy is positive their shared laughter may include admiration for the creator, whereas if it is negative, they may have shared ridicule of the creator. When people detect a discrepancy in an object of animistic projection such as a cat, and if they experience it alone, it is only results in curiosity. However, for example, if you and your partner see a cute cat go flying in the air after her failed attempt to climb on the bed, you may share a laugh over the cat. However, if you find a cockroach in your kitchen (cockroaches should not be there!), you and your partner may have shared disguised curiosity and cry "How did this cockroach come into the kitchen?" Finally, a physical object does not usually cause a laugh.

The "time budget mode" theory (Dunbar, 2014) assumes that humans have evolved many kinds of strategies as social mammals, to preserve their group harmony and keep their group cohesive with less investment. Laughter can be regarded as one of the strategies in the sense that it enhances group harmony. However, it is not a direct product of System 1. This product can be under the control of System 2, which is used either for affective laugh or ridicule. Laugh can be an insult if used for ridicule. In the first place, laughter is one of the consequences after detecting a discrepancy. Therefore, people have to be careful not always to express laughter automatically after detecting a discrepancy. They need to engage in deliberate thinking before expressing laughter.

LAUGH AND LAUGHTER IN THE DOMINANCE HIERARCHY

As mentioned earlier, while laughter is one of the effective strategies to preserve group harmony, and thus helps Homo sapiens save time for other activities, it can also be an aggressive insult against an individual to point out that his or her action deviates from societal norms. This aggressive ridicule or mocking laugh can also be adaptive in a society of dominance hierarchy (Weisfeld & Dillon, 2012). Dominance hierarchy arises when members of a social group interact, to create a ranking system. As a social mammal, take primates for example, group members are likely to compete for access to limited resources and mating opportunities. The dominance hierarchy system is a strategy to avoid group members fighting each time they meet, by fixing an order of priority for eating and mating.

However, it is a disadvantage for lower-ranking members to survive and reproduce in the dominance hierarchy regime. If an individual tries to take food before his or her higher-ranking members, it is very likely that he or she is attacked by them, or even killed in the worst case. Therefore, he or she has two strategies. Both of the strategies are based on ToM, which evolved to solve the adaptive problems in the dominance hierarchy system (Cummins, 1998). One is to cheat the higher-ranking members. For example, Menzel (1974) reported cheating by a young male chimpanzee. He was young and small and thus his ranking was low. He did not want his food to be found by his foraging competitors whose ranking was higher than his. He hid his food in his cache, but gazed at another place as if he hid his food there. In short, he knew that his competitors thought that something to eat was hidden in the place he was gazing at.

The second strategy is to align with each other. Even a lower-ranking member, if he or she aligns with other group members, can resist pressure from a higher-ranking member. Furthermore, it is possible for him or her to beat a higher-ranking member with the help of his or her allies and thus to rise in rank in the group. He or she can become a winner in the dominance hierarchy. This alignment is possible because he or she can perform mindreading of other members and establish trust relationships with them. In short, it is supported by the theory of mid module.

Correspondingly, higher-ranking members also have two adaptive problems in the dominance hierarchy group. Their adaptive problems are, first, not to be cheated by their lower-ranking members and second, not to be overturned by lower-ranking members in their group. The strategies to solve both problems require mindreading abilities. In the first case, they need to be able to use mindreading to detect those who try to cheat them. In the second case, an effective strategy is to establish alignments with other group members. This is almost the same strategy which the lower-ranking members adopt against pressure from the higher-ranking members.

Laughter brings three kinds of benefits in this alignment. First, it strengthens the alignment among both higher-ranking members and lower-ranking members, as mentioned in this section. Laughter creates a positive group atmosphere (Curseu & Fodor, 2016). Second, if the target of laughter is a rival in the ranking system, the laughter not only strengthens the laugher's alignment with his or her sympathizers, but also shows that the target should be ridiculed in the group. The ridicule is effective in degrading the ranking of the rival (Weisfeld & Dillon, 2012). It is also likely that when one is ridiculed, his or her self-esteem is degraded. Third, laughter is more polished and sophisticated than a violent attack. Even if you ridiculed someone, it is possible that people will not regard you as one who is uncultured, rough, and violent. An individual who is regarded as violent is likely to be kicked out of his or her group, from a long-term perspective. People believe that humor reflects one's intelligence. This will be discussed in the next section.

Finally, the reason why self-deprecating humor is funny is discussed within the frame of the dominance hierarchy hypothesis (e.g., Greengross & Miller, 2008). Self-deprecating humor shows a discrepancy between the general human tendency to wish to be expected and what is actually performed. This discrepancy may cause curiosity in those who do not know self-deprecating comedy. However, it is much more likely that it causes laughter among those who are watching the performance, and the performer is also caught in the whirlpool of laughter. Even if people have no explicit hierarchy of dominance in contemporary society, Homo sapiens inherit this system, being one of the primate species. Hence, self-deprecating humor reassures people that the performer has no intention to raise his or her ranking status.

LAUGH AND LAUGHTER IN THE CONTEMPORARY WORLD

Humor as a Measure of Intelligence

Although a "laugh" module is not thought to exist, it does not mean that laughter is free from evolutional adaptation. As mentioned earlier, laughter has many adaptive functions for Homo sapiens as a social mammal. On the other hand, it is also true that people are required to have high intelligence to understand and produce humor for laughter in the contemporary world. The modern times can be described through many points of views: prosperity, mass media society, information technology, collapse of traditional community, and so on. The historic turning point for modern prosperity was the industrial revolution of the 18th century. The industrial revolution

facilitated division of labor. Generally, division of labor relies on specialization, which makes production efficient. It is plausible that the social exchange module has contributed to division of labor and is the base for the creation of this large, modern economic system.

Humor which makes people laugh can be a measure of the performer's intellectual ability in this modern world. We are in the modern society in which information levels are high, as both the cause and consequence of prosperity. As mentioned previously, an individual who shows a discrepancy can be a target of laughter and hence his or her ranking position is likely to be degraded. However, after new media such as the television spreads trends, comedians come to compete for laughter. Since varied kinds of humor have been created by many comedians, people do not laugh at commonplace humor. Therefore, in this modern society, humor can be a measure of intelligence and creativity. Greengross and Miller (2011) reported that humor is strongly related to high intelligence and thus leads to successful mating. Furthermore, Kellner and Benedek (2017) found that the ability to be humorous is predicted not only by intelligence, but also creativity.

Actually, in order to make people laugh, you have to consider many factors. You need to know the common sense which people have and to understand how people detect discrepancy. These require higher levels of intelligence. Furthermore, you have to take care so that your humor (or joke) does not hurt anybody. This requires emotional intelligence.

Furthermore, humor can be an indirect criticism and thus is regarded as a gentle strategy for criticism. You are viewed as a considerate person if you criticize someone with humor in place of an aggressive direct attack. That is, you are regarded as a highly intelligent individual. For example, irony is one of the most indirect criticisms. You can give a target person an inkling of his or her unsuitable behavior ("discrepancy" in other words) using irony. The use of irony entails indirectly conveyed beliefs and attitudes that constitute the speaker's intended meaning. The development of understanding irony is associated with the development of ToM (Filippova & Astington, 2008). People have to read the speaker's intention when understanding irony.

Laugh and Laughter in the Frame of Contemporary Communication

Although laugh, laughter, and humor have been adaptive, as repeatedly mentioned in this chapter, the risks attached with these are increasing in the modern world. Generally, people use the contextual background to understand humor. Whether

the pointing out of a discrepancy is understood as humor depends on the context which people share, like common knowledge. For example, many people may have an experience of being puzzled by a joke of a comedian abroad. It is because they do not share the common sense with the people in the country and thus, are not able to detect the discrepancy pointed out by the comedian. In short, the context is unavailable to the listener to understand what is expected in the specific culture. The term "context" is theorized by Hall (1976). He introduced "context" as a dominant cultural dimension to explore the relationships between culture and communication. He defines context as the relevant information about or stimuli to the target. The dimension of context provides a framework that enables people to comprehend communication forms ranging from purely nonverbal, such as hand gestures, body language, facial expressions, and tone of voice, to purely verbal aspects, such as written text or spoken words, with the ultimate aim of achieving meaning. Hall and Hall (1990) integrated three main concepts: context, information, and meaning. These combined concepts encapsulate context as a system of meaning for information exchange between people. Context is embedded in information with the purpose of creating meanings from a message.

Hall (1976) also proposed a dimension between a high-context culture and a low-context culture. People in a high-context culture can interpret messages from others without full descriptions, because implicitly shared information is available for their interpretation. Such shared information is further facilitated by the established relationships among the members in a group. Conversely, people in a low-context culture need explicitly expressed words for communication because they cannot use implicitly shared information as much as those in a high-context culture. Hence, they rely on content-dependent communication, which is direct and explicit. Generally, Westerners are said to be in a low-context culture, whereas Easterners are in a high-context culture (Hall, 1976; Yama & Zakaria, 2019).

The division of labor supports modern prosperity. However, it has brought about the collapse of the traditional community everywhere in the contemporary world. In the process of industrialization, many people left their traditional communities for cities, to get a good paying job. People, particularly young people, have not been satisfied with traditional living such as agriculture. As a result of this move, more anonymous communities have been born in city areas in many industrial countries after World War II. People live in an apartment or a house in emerging residential areas, and hence human relationships in a local community are not as strong as they used to be. People do not know the cultural background of each other. Within a low-context culture, they have to be mindful of their communication so that they

can convey their message despite the different cultural backgrounds. However, if they stick to their traditional communication style which they adopted in their traditional community, such as in a high-context culture, they fail to be successful at communicating. In short, although people rely upon context less, they have not yet created a lower-context culture which is suitable for modern times.

Globalization caused by industrialization has made it difficult for people to communicate successfully. The golden rule "Do unto others as you would have others do unto you" (the Gospel of Matthew 7:12) does not work while communicating with others from different cultural backgrounds. This is also the case in laughter and humor. The rule that others laugh at a joke which you laugh at does not work in modern society. It is possible that people with different cultural backgrounds understand a discrepancy in different ways.

Furthermore, laugh and laughter can be very risky where context is not available but people believe it to be. As shown in Table 2, laugh and laughter works differently in different conditions. If the one who causes a discrepancy has a different cultural background from yourself, you have to be very careful before you laugh at the person. Even if you intend to do him a favor by laughing at his mistake and you expect that he or she will laugh with you, there is a possibility for him or her to regard your laugher as ridicule or insult. He or she may have grown up in a culture where people regard laughter as vulgar and insulting in most cases. His or her culture may have a social norm that one should not laugh at a person unless they are very close to them. This risk also applies when you expect your laughter at a target person to be shared by other people in such a cultural society. It is possible that you will be judged as an impolite person and your laughter will not be infectious.

Although it has been mentioned that a self-deprecating joke is likely to be favored in view of the dominance hierarchy, it is possible that this joke is not accepted in a cultural society where what people say is likely to be interpreted literally. For example, when you exclaim what an idiot you are, you may expect that your listeners will laugh at you in a friendly manner. However, if they understand your message literally, they may think that you have recognized yourself to be an idiot, and may feel very sorry for you as a miserable person. In another case, some self-deprecating jokes are not acceptable if they can hurt someone else. For example, when a pushing-forty, single, good-looking actress says in a self-deprecating manner "I cannot get married anyway," many people may smile at her joke. However, it is likely that her joke may hurt single women who choose their single life for their own sake, interpret her joke as presupposing that a single life is miserable, and find it unpleasant. Self-deprecating jokes were acceptable as a sign of no will to raise one's ranking position in the dominance hierarchy. However, in this contemporary world of information society, even a self-deprecating joke or humor is not acceptable in some cases.

On the other hand, it is less often that your mocking laugh is misunderstood to be a friendly laugh. How is the misunderstanding biased? Generally, in the process of creating a low-context culture, people come to be sensitive to behaviors which are potentially insulting. Hence, jokes which used to be acceptable can be impolite these days, as shown in the example of the single actress. Now, people know that they cannot adopt the communication style which was common in traditional communities, to communication in the modern world. In the process of industrialization and collapse of traditional communities, people know that it is always uncertain whether their message can be understood by others as they intended. Hence, even if they create a new community in their school, company, and place of residence, their relationships are ad hoc and not as close as they were in traditional communities.

As a consequence, people participate in community activities, apart from their job, less than they used to. Putnam (2000) describes this as decrease in social capital. Social capital refers to the factors of effectively functioning social groups, such as interpersonal relationships, a shared sense of identity, a shared understanding, shared norms, shared values, trust, cooperation, and reciprocity. Those who work for a company and are satisfied with their income usually do not feel the need for social capital. However, when they need someone's help because of unemployment, disease, trouble with others, and so on, it is social capital that can help them. If they have rich social capital, it is more likely that they can resolve these difficulties. Furthermore, those who have rich social capital are generally more likely to have good mental health (Almedom, 2005). This effect is parallel to the fact that humor, laugh, and laughter are effective to keep human mental health better (Martin, 2001).

CONCLUSION

Laugh, laughter, and humor can be regarded as a strategy of Homo sapiens to preserve their groups in harmony. However, there is likely not a "laugh" module in System 1, which is assumed to be an evolutionarily older system. Laugh and laughter are not modular. Rather, these are triggered by the detection of a discrepancy, by a module of System 1. For example, the naïve physics module detects a steel ball which is rising. This motion is against the law of free fall, and thus is a discrepancy. Laughter may arise if you think of the ball as a small animal (animistic projection), and if you are watching this motion with your friend, you think that your friend finds it funny, and expect that your laughter is infectious to your friend.

Therefore, although laugh, laughter, and humor are not direct products of System 1, akin to religion, they contribute to group harmony and allow Home Sapiens to save time for other activities. However, because their trigger is the detection of

a discrepancy, they can also arise from ridicule and/or insult. Both positive and negative functions of laughter are adaptive in the dominance hierarchy that primates, as social mammals, have. The positive function is useful when members want to align together. Their alliance is of advantage for raising their ranking within the group. The negative function of ridicule or insult is effective when a member tries to degrade the ranking of his or her rival. In this sense, self-deprecating humor which comedians often use is accepted because it shows that the user has no ambition to raise his or her ranking in the group.

The modern world is characterized by the collapse of traditional communities and people are now less able to rely on context when communicating with others. Therefore, a high skill in humor is required to catch people in a whirlpool of laughter. Hence, people who use a high level of humor are not only regarded as intelligent, but also actually are. Laugh and laughter can also be risky in this modern world, as people are sensitive not to hurt others. Even self-deprecating humor comes under criticism sometimes. This happens when the discrepancy which the comedian points out is shared by the listener, who feels like he or she has been insulted by the comedian.

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Chapter 8
What Society Can and Cannot Learn From Coherence:
Theoretical and Practical Considerations

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ABSTRACT

Society is facing uncertainty on a multitude of domains and levels: usually, reasoning and decisions about political, economic, or health issues must be made under uncertainty. Among various approaches to probability, this chapter presents the coherence approach to probability as a method for uncertainty management. The authors explain the role of uncertainty in the context of important societal issues like legal reasoning and vaccination hesitancy. Finally, the chapter presents selected psychological factors which impact probabilistic representation and reasoning and discusses what society can and cannot learn from the coherence approach from theoretical and practical perspectives.

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INTRODUCTION

Society is facing uncertainty on a multitude of domains and levels: usually, reasoning and decisions about political, economic, or health issues have to be made under uncertainty. Probability theory allows for modeling belief states of incomplete and uncertain knowledge. Among various approaches to probability, the authors advocate the coherence approach, which goes back to Bruno de Finetti (see, e.g., 1937, 1974). The introduction presents a brief informal description of the theory of coherence. Contrary to standard approaches to probability, the coherence approach does not presuppose a definition on a complete and exhaustive mathematical structure: rather, it works with partial assessments of just those events which are of interest. This feature makes the coherence approach to probability psychologically appealing: it is plausible to assume that people draw inferences directly without storing and processing rich and complex mathematical structures like algebras. Moreover, conditional probability—which is the best predictor for human reasoning about uncertain conditionals—is primitive in the coherence approach. Therefore, probabilities can be assigned directly without building the fraction of the joint probability (i.e., the probability of the conjunction of the antecedent and the consequent) and the marginal probability (i.e., the probability of the antecedent). In everyday contexts, for example, people can assess their degree of belief in a conditional like "if Max enters the train at 6 o'clock, then Max will be home at 7 o'clock" directly, without firstly forming and secondly dividing the probability of the conjunction "Max enters the train at 6 o'clock and Max will be home at 7 o'clock" by the probability of the antecedent "Max enters the train at 6 o'clock". Therefore, human reasoning under uncertainty is modeled more naturally by the coherence approach compared to standard approaches to probability. Furthermore, coherence allows for imprecise probabilities (i.e., interval-valued probabilities): this feature becomes relevant when there is not enough information to give point-valued assessments. Also, conclusions may be imprecise even if the premises are precise: for example, from the precise premises P(Max enters the train at 6 o'clock)=.8 and P(Max will be home at 7 o'clock *given* Max enters the train at 6 o'clock)=.9 only the imprecise conclusion that $.72 \leq P$(Max will be home at 7 o'clock)$\leq .92$ is coherent can be drawn (see, e.g., Pfeifer & Kleiter, 2006, 2009). Moreover, the coherence approach shows its full potential when the premise set does not only contain probabilistic information but also logical information about logical interconnections (like logical implications, incompatibilities, exhaustiveness, etc.).

In betting terms, coherence means, roughly speaking, the avoidance of bets which lead to sure loss: this is, according to coherence, the prime rationality criterion for probabilistic inference. For probabilistic inferences, coherence requires

a coherent assessment of the premises to start. If the premise set is incoherent, the reasoner has to adjust the premises to obtain a coherent premise set (which may also contain logical information). If the premise set is coherent, an inference can be drawn about a conclusion which may be probabilistically informative (i.e., the conclusion is constrained by a probability interval or by a point probability value) or probabilistically non-informative (i.e., the unit interval [0,1] is a coherent assessment of the conclusion). Coherence allows for identifying the best possible bounds on the conclusion. However, for applications in everyday life scenarios, such an inference is just as good as the premises are: if the degrees of belief assigned to the premises are mistaken, then the conclusion will, of course, not be trustworthy. This is relevant, for example, for evaluating whether some news are "fake news": a high degree of belief in the conclusion could appear to be justified just because it follows coherently from the premises. However, if the premises are based on fake news it is highly probable that the conclusion is fake news as well (or, but unlikely, it could turn out to be true for other reasons which are independent of the premises). Thus, coherence allows only for checking the coherence of premises and to extend the degrees of belief from the premise set in a rational way to the conclusion. Coherence does not provide a method for ultimately judging the credibility of the premises (risk research—see, e.g., Fischhoff & Kadvany, 2011—and calibration research provide methods and tools for the "correct" establishment of subjective degrees of belief in the premises of interest; see, for example, Kleiter, Doherty, & Brake, 2002). It only tells whether they are coherent, which, as we will explain, means to say that the axioms of probability theory are satisfied and that there is no bet which leads to uniform sure loss (no Dutch book).

What can society learn from coherence? This chapter presents coherence as a method for uncertainty management. For example, the authors explain the role of uncertainty in the context of unexpected (rare) scenarios. Unexpected and rare scenarios deserve special attention because they can have major impacts on society like volcanic eruptions or severe nuclear accidents. Moreover, contrary to standard approaches to probability, the coherence approach can properly manage conditioning on zero probabilities. The authors discuss and explain the relevance of coherence for important societal problems including legal reasoning and fake news in the context of vaccine hesitancy. Finally, the authors present the availability heuristic and the belief bias as selected examples of psychological factors which impact on probabilistic representation and reasoning.

BACKGROUND: THE COHERENCE APPROACH TO PROBABILITY

As already briefly stated, the authors of this chapter propose the use of the notion of coherence of probability statements. As only an informal and superficial sketch of the theory can be given, the interested reader is referred to the fully detailed and rigorous description in the book by Coletti & Scozzafava (2002).

The coherence approach to probability was introduced by Bruno de Finetti (see, e.g., 1937, 1974). Ontologically speaking, probabilities are conceived as subjective degrees of belief and not as an objective quantity of the "objective world" (like in frequentist approaches to probability, which conceive probability as relative frequencies in the limit of a large number of experiments or trials). It goes back to the 1930ies and became widely known in the 1970ies. Coherence allows for assigning probability values even in the context of incomplete information and in structure free situations, independently of the source of information based on which the probabilistic assessments are obtained (e.g., subjective assessments of single cases[1], statistically estimated random processes, frequency limits of repeated occurrences, as a result of an agreement among a pool of experts or of a calibration process of a decision maker). Traditional approaches to probability, however, are governed by simple and intuitive axioms, namely by the well-known Kolmogov axioms of probability (Kolmogoroff, 1933). Intuitively, they guarantee, for example, that probabilities are in the real-valued interval between zero and one, [0,1], and that all probabilities on an algebra of events should add up to one. Thus, the probability of a certain event (e.g, "the earth is round *or* it is not the case that the earth is round") is equal to one and the probability of an impossible event (e.g, "the earth is round *and* it is not the case that the earth is round") is equal to zero. In contrast to the coherence approach, Kolmogorovian probability is defined on a fully structured domain, usually characterized by algebras or sigma-algebras. Kolmogorovian probability requires a structure which is extended by additivity. In everyday life situations, and especially in human thinking and reasoning, however, it is more natural to focus on just a bunch of events, which are then assessed probabilistically, instead of requiring assessments of full algebras. Consequently, in the coherence approach, interconnections or incompatibilities among the events in question play a crucial role. For making (rational) assessments of such partial domains, which need to be consistent and in accordance with the laws of probability, it is not sufficient to respect Kolmogorov's axioms: rather, a further requirement is needed: the chosen probability values must be constructed in such a way that they cannot be used to

construct a so-called "Dutch book". A Dutch book is a hypothetical combination of symmetric bets, where the player or the banker can switch each other's bets, such that it will lead to a sure win (or a sure loss). For example, if you are offered a soccer bet for 10 EUR that Torino will win in the next match against Real Madrid, and you will receive 5 EUR when Torino wins and you will receive nothing when Real Madrid wins, you will face a Dutch book. Whatever the outcome of the match will be, you will lose. The semantic requirement to avoid Dutch books is equivalent to the syntactical requirement of the solvability of a specific linear system that reflects the existence of at least one standard probability distribution which is compatible with the initial probability assessment. This equivalence is characteristic for coherence and permits the decision maker, or simply the evaluating person, to focus on being careful to avoid potential sure "loss" induced by his/her assessments, without caring about mathematical technicalities like respecting abstract axioms or ensuring the solvability of linear systems, since these could remain hidden in the "background". The probability assessments must simply satisfy the known constraints of the inferential process. Thus, whether the inferred coherent consequences are reasonable or not depends on the input premises. If they are mistaken, then the conclusion will most probably be mistaken. If they are correct, then the conclusion will be correct. Checking the coherence of the probability propagation from the premises to the conclusion is done through a mathematical procedure that may remain like a "black box" for common users, who might use, e.g., a software for checking coherence (see the "Check Coherence" package, which is presented below).

Coherence is not only important for situations of incomplete knowledge and structure free situations. Coherence also plays an even more crucial role when it comes to probabilistic assessments of conditionals. In fact, when you have to evaluate and manage conditional probability assessments under different hypothetical scenarios, things become more intriguing and frequently counterintuitive. Standard Kolmogorovian probability theory defines conditional probability by the ratio of unconditional probabilities and thereby eliminates the term conditional probability. Kolmogorovian probability theory defines the conditional probability *P(E|H)*, simply by the following ratio:

$$P(E \mid H) = \frac{P\left(EH\right)}{P\left(H\right)}$$

where E is the event under evaluation, H is the hypothetical scenario, and EH is the conjunction of *E* and *H*. The stroke "|" can be read as "given", which separates the condition*ed* event (*E*) from the condition*ing* event (*H*). To avoid fractions over

zero, this definition requires of course that $P\left(H\right) > 0$. This requirement of strictly positive probabilities of the conditioning event, $P\left(H\right) > 0$, makes it is unable to condition on exceptional and unexpected situations *H*, which may indeed have probability equal to zero. Moreover, this fractional definition downgrades the conditional probability to a derived concept since its definiens consists of unconditional probabilities. Furthermore, the meaning of *P*(*E*|*H*) can only be given when both *P*(*EH*) and *P*(*H*) are given.

In everyday life, however, it is quite natural for people to *directly* evaluate events on the basis of specific contexts and also to contemplate unexpected scenarios based on the occurrence of extremely rare (i.e., probability zero) situations. This can be done within the coherence approach to probability, and again without requiring any specific mathematical structure on the domain of discernment. The key idea is to require that a different kind of a composed bet does not lead to sure win (or sure loss): this bet contains the possibility of "calling off" those elements for which the conditioning events do not realize. *Calling off* means to give back the corresponding stakes. For example in a fair soccer bet, you will receive back what you paid in case the match is called off. This is again a semantic interpretation of coherence which syntactically translates into the existence of a finite list of linear systems, with each one corresponding to a specific level of unexpectedness of some conditioning event, which corresponds to the compatibility of the given values with a so-called "full" conditional probability distribution. Full conditional probability distributions (e.g. those à la Kraus, 1968, or Dubins, 1975) are characterized by respecting other quite intuitive axioms, similar to those of Kolmogorov but with a further one specific to conditional probabilities, and defined on a well structured mathematical domain (specifically, on a Cartesian product of an algebra with an additive subset). But what is important is exactly what better reflects human thinking: conditional probabilities are "primitive" concepts, not derived by the unconditional ones, but obviously with them strictly interconnected; it is perfectly reasonable and possible to evaluate events which are conditioned on extremely rare and unexpected scenarios, a priori thought to have zero probability to happen. Usually, the latter requirement is solved by giving a negligible, but positive, probability value to a rare or unexpected situation. But, apart from usually being absolutely arbitrary, such small values induce on one side an extreme sensitivity on the inference process, i.e. small variation on initial values can induce very different conclusions, while, on the other side, they do not permit to enlarge dynamically the domain to new unexpected scenarios without rescaling all probabilities previously assessed.

Although, as already mentioned, conditioning probability is well-defined even when conditional events may have zero probability, conditional probability is undefined in the coherence approach when the conditional events denote logical falsehoods (i.e., contradictions). For evaluating a conditional probability it is essential to (hypothetically) assume the truth of the conditioning event. Of course, it makes sense to assume an extremely rare event which has a zero probability. However, it does not make sense at all to assume a logical contradiction. For example, it does not make sense to think about whether Torino will win, conditioned on the contradictory event that Torino plays and does not play. The event "Torino plays and Torino does not play" cannot be true in any case. Finally, note that even if coherence requires that contradictories must have probability zero, the converse is not true: an event having probability zero does not mean that this event is an impossible event (or a contradiction).

For numerical calculations the reader is referred to the free Check Coherence software developed by Baioletti et al. (2016, version 6) as described by Capotorti & Vantaggi (2005). The software allows for precise and imprecise probability assessments on conditional and unconditional events and for logical relations among events as input. Then, the software checks if the initial input assessment (i.e., the premise set) is coherent. If it is incoherent, the user needs to adapt the input assessment such that it becomes coherent. From an incoherent premise set the software can only draw the conclusion that it is incoherent. If the input assessment is coherent, the user may input another usually new (conditional or unconditional) event (i.e., the conclusion) and then the software can compute the best possible coherent lower and upper probability bounds on this new event. The output can be (i) a point value or (ii) an imprecise probability (i.e., a lower and an upper probability bound). The coherent imprecise probability on the conclusion can be (ii.1) a proper subset of the unit interval or (ii.2) coincide with the unit interval. Of course, if the output corresponds to case (ii.2), the inference from the premises to the conclusion is "vacuous" in the sense that these premises do not constrain the conclusion.

Such conclusions can be seen as a generalized Bayesian inference: in fact, if the (coherent) input provided by the user is sufficiently informative to induce a unique compatible probability distribution on the "unexpectedness"-layer of the scenario H, the point valued output (i) coincides with the output of the usual Bayes' formula. Bayes' formula is defined by the product of the "a priori" probability $P(E)$ times the "likelihood" $P(H|E)$ and divided by the probability of occurrence of the scenario $P(H)$. If, however, the user assessments are compatible with more than one probability distribution, then an imprecise (interval-valued) output (ii) results, which

corresponds to the union of all Bayes' formula outputs implied by each probability distribution which is compatible with the users' initial probability assessment (for a more detailed and exhaustive description of the inference process refer to Coletti & Scozzafava, 2002, chapters 13-16).

In realistic scenarios, the output is often an imprecise probability since in many real world applications not enough information is available for drawing precise (point-valued) probability assessments on the conclusions. Furthermore, it is not uncommon to obtain probability zero as a possible coherent conclusion probability. This result can then be used within the premise set of a further argument. In particular, such events with probability zero can serve as conditioning events in new premise sets. Thus, zero probabilities can arise quite naturally and it is important to manage them properly. As already mentioned, the coherence approach can properly manage zero probabilities.

UNCERTAINTY, VACCINE HESITANCY, AND FAKE NEWS

According to the World Health Organization, vaccine hesitancy belongs to the ten threats to global health in 2019:

Vaccine hesitancy—the reluctance or refusal to vaccinate despite the availability of vaccines— threatens to reverse progress made in tackling vaccine-preventable diseases. Vaccination is one of the most cost-effective ways of avoiding disease—it currently prevents 2-3 million deaths a year, and a further 1.5 million could be avoided if global coverage of vaccinations improved. Measles, for example, has seen a 30% increase in cases globally. The reasons for this rise are complex, and not all of these cases are due to vaccine hesitancy. However, some countries that were close to eliminating the disease have seen a resurgence. (WHO, 2019)

This section focuses on vaccine hesitancy with respect to measles as an example. It explains how the coherence approach to probability can help to identify fake news in society. Vaccine hesitancy with respect to measles is a consequence of harmful and popular fake news concerning the alleged risk of autism spectrum disorder (ASD, short autism) induced by the measles-mumps-rubella vaccination (MMR) and by the problematic view that measles is harmless. MMR causing ASD was claimed in the year 1998 in a study by Wakefield et al. (1998) who published a series of 12 case studies in The Lancet. The Lancet is one of the oldest, highly prestigious,

high impact, and best known general medical journals. The Wakefield et al. (1998) study suggests an association between MMR vaccination and autism. However, this association could not be substantiated since it turned out that Wakefield et al.'s research was fatally flawed (see, e.g., Deer, 2011). Moreover, most of the co-authors of the study retracted the interpretation in the paper. Consequently, The Lancet formally retracted the paper in 2010. However, proponents of vaccine hesitancy still tend to believe that MMR raises the risk to develop autism, which has grown into a huge social anti-vaccination movement in recent years. Let us see how coherence could help to derive a correct conclusion, even when the values of the retracted paper are used and known population parameters are considered. One of the main criticisms of Wakefield et al.'s paper, apart from the hidden fraud in reporting the data, was due to the absence of a "control" group (i.e., cases of not vaccinated individuals), which left the study not only fraudulent but also incomplete. By the application of the theory of coherence we can manage such incompleteness and unmask Wakefield et al.'s interpretation (which justifies an anti-vaccination policy) as incorrect.

Analysing the Wakefield et al. study we select the following three binary, i.e. dichotomous, variables:

- **Vaccination:** The state of having received an MMR vaccine in the recent past
  - Events representing the status: VAX or NO_VAX
- **Real Autism:** The real presence of autism spectrum disorder
  - Events representing the status: ASD or NO_ASD
- **Assessed Autism:** The state of having the characteristics to be reported as an ASD in the Wakefield et al. study
  - Events representing the status: ASSESSED_asd or NO_ASSSED_asd

Are there any logical relations among these events in question? For simplicity, let us set aside measurement errors in diagnosing ASD and assume that having ASD will also lead to its diagnosis (ASSESSED_asd) for sure, which is expressed by ASD ⇒ ASSESSED_asd (read: "if ASD, then ASSESSED_asd"), where "⇒" denotes logical entailment (A⇒B means that "not-A or B" is a tautology).

In the Wakefield et al. study 9 over the 12 recently vaccinated patients were reported to have developed the autism spectrum disorder: if we integrate such information with the incidence values of real autism in the current population and with a realistically estimated percentage of vaccination coverage, we arrive at the following initial probability assessment:

- P(ASSESSED_asd | VAX) = 9/12 = 75% (frequency reported in the study)
- P(ASD) = 1.47% = 1/68 (incidence of autism in the population)
- 91% $\leq P$(VAX) $\leq$ 92% (reasonable range of the percentage of vaccinated people)

These values are coherent, i.e., they are compatible with at least one probability distribution. In fact, it is possible to build (obviously only potentially, the mentioned software doing it automatically and internally for us) any possible "elementary" combination of the involved events, i.e. the so-called "atoms" of the minimal algebra containing the events VAX, ASD, and ASSESSED_asd. In this case there are six atoms (instead of eight atoms of a free algebra we would obtain if we would not have the logical constraint ASD $\Rightarrow$ ASSESSED_asd):

- A1 = NO_VAX & ASD & ASSESSED_asd;
- A2 = VAX & ASD & ASSESSED_asd;
- A3 = VAX & NO_ASD & ASSESSED_asd;
- A4 = NO_VAX & NO_ASD & ASSESSED_asd;
- A5 = VAX & NO_ASD & NO_ASSESSED_asd;
- A6 = NO_VAX & N0_ASD & ASSESSED_asd.

Given the initial probability assessments, the probabilities of the atoms are then constrained as follows:

- P(A2)+P(A3) = 0.75 (P(A2)+P(A3)+P(A5));
- P(A1)+P(A2) = 0.0147;
- 0.91 $\leq P$(A2)+P(A3)+P(A5) $\leq$ 0.92;

with P(Ai) $\geq$ 0, i=1,...,6, and P(A1)+P(A2)+P(A3)+P(A4)+P(A5)+P(A6) =1.

Note that the last value for the percentage of vaccinated people P(VAX) has been estimated by an interval with a minimum and a maximum value. The imprecise (interval-valued) assessment corresponds to the uncertainty in the official estimations and matches the realistic situation better compared with a precise (point-valued) assessment. This interval does not cause any trouble for checking the coherence of the overall assessment, since it simply implies that we consider an entire set of probability distributions as compatible and not a single one (e.g., the constraints imply that P(A1) could range between 0 and 0.147, while P(A3) could range between 0.6678 and 0.69, etc.).

The reasoning target is to ask if MMR vaccination effectively causes autistic disorder ASD, hence to compute coherent bounds for $P(\text{ASD} \mid \text{VAX})$. With the given assessment we obtain:

$$0 \leq P(\text{ASD} \mid \text{VAX}) \leq 1.62\% \, .$$

Such bounds are obtained through solving optimization problems of systems of equalities and inequalities. In these systems, the objective function $P(\text{A2})$ is to be minimized/maximized under the aforementioned constraints plus the additional constraint that $P(\text{A2})+P(\text{A3})+P(\text{A5}) = 1$ (such an additional constraint is used for technical reasons: it permits the optimization problem to be linear and not fractional; for further details refer again to Coletti & Scozzafava, 2002, chapter 13).

Thus, only the worst case, i.e. with a pessimistic attitude, seems to show a slight increase with respect to the a priori incidence (1.62% against 1.47% with a negligible increase of 0.15%). But when a risk factor is measured in subgroups of the population, we have to compare such value with that obtainable from the other part of the population of not vaccinated people, i.e. the aforementioned missing "control group". Quite surprisingly, through coherence, we actually obtain:

$$0 \leq P(\text{ASD} \mid \text{NO\_VAX}) \leq 18.382\%$$

that shows a huge possible increase of the risk! Obviously such worst increment is absolutely unrealistic. It brings the false hypothesis that MMR vaccination is a possible cause of ASD to light.

Note that, if we compute the coherent bounds of the flawed reported case study, we obtain

$$66.779\% \leq P(\text{NO\_ASD and ASSESSED\_asd}) \leq 75.779\% \, .$$

This shows that, anyhow, more than ⅔ of the assessed cases in the Wakefield et al. study were wrongly reported, as was actually shown by a posteriori analysis (see Deer, 2011).

Note, finally, that in the discussed example of vaccination hesitancy, the unexpected results are not due to the contemplation of unexpected scenarios (here, the VAX or NO_VAX hypotheses are strictly positive and are quite distant to probability zero). Rather, the unexpected results are due to wrong and mistaken causal assumptions (for more on vaccination, measles, and society, see, e.g., Omer, Betsch, & Leask, 2019).

FORENSIC UNCERTAINTY AND PROBLEMATIC USES OF EVIDENCE IN TRIALS

Another important field where uncertainty plays a crucial role but where common reasoning could lead to misleading conclusions is the legal use of specific evidence detected on crime scenes. One of the most popular examples of evidence—which is often characterized in the mass media as one of the most convincing kinds of evidence—is DNA evidence. Even if DNA evidence counts as a sophisticated and highly specific and reliable technique, the compatibility of DNA profiles between a crime suspect and a sample found at the crime scene is prone to mistakes and misunderstandings. What are the essential elements of DNA evidence? Suppose a test is conducted to compare the DNA profile of a suspect with a sample found at a crime scene. Following the description by the National Institute of Justice how DNA profiling works (NIJ, 2012), there are three possible and mutually exclusive results of such a DNA test: EXCLUDED (there is sure incompatibility between the suspected person and the unknown owner of the DNA sample), COMPATIBLE (there is a correct match between the two profiles) or INCONCLUSIVE (the amount of DNA in the sample is too low or it results in a mixed sample involving several subjects). The EXCLUDED result is generally accepted as a sure proof of innocence, hence incompatible with the real guilt of having committed the crime. On the other side, INCONCLUSIVE leaves the decision maker (usually the court) with absolute uncertainty about the real origins of the DNA samples, in particular whether the DNA sample found at the crime scene matches the suspect's DNA or not. Suppose also that the police is highly confident that the GUILTY person is among the SUSPECTED people. If we consider the following conditional probabilities:

- $P(\text{GUILTY} \mid \text{EXCLUDED}) = 0$ (innocence proof)
- $P(\text{GUILTY} \mid \text{INCONCLUSIVE}) = 50\%$ (maximum uncertainty)
- $P(\text{GUILTY} \mid \text{SUSPECTED}) = 95\%$ (reasonable accuracy of police's investigation)

and if we assume that the EXCLUDED result is logically incompatible with the GUILTY result and that the three possible test results are complete and mutually exclusive, we obtain a coherent initial probability assessment. Note that the technical computations would be similar to those in the vaccination hesitancy example discussed in the previous chapter but now with 9 possible atoms—instead of 32 of the free algebra—and with 9 associated degrees of freedom for constructing the atoms' probabilities:

- A1= EXCLUDED & NOT_COMPATIBLE & NOT_INCOCNLUSIVE & NOT_SUSPECTED & NOT_GUILTY;
- A2= NOT_EXCLUDED & COMPATIBLE & NOT_INCOCNLUSIVE & NOT_SUSPECTED & NOT_GUILTY;
- A3= NOT_EXCLUDED & COMPATIBLE & NOT_INCOCNLUSIVE & SUSPECTED & NOT_GUILTY;
- A4= NOT_EXCLUDED & COMPATIBLE & NOT_INCOCNLUSIVE & SUSPECTED & GUILTY;
- A5= NOT_EXCLUDED & COMPATIBLE & NOT_INCOCNLUSIVE & NOT_SUSPECTED & GUILTY;
- A6= NOT_EXCLUDED & NOT_COMPATIBLE & INCONCLUSIVE & NOT_SUSPECTED & NOT_GUILTY;
- A7= NOT_EXCLUDED & NOT_COMPATIBLE & INCONCLUSIVE & SUSPECTED & NOT_GUILTY;
- A8= NOT_EXCLUDED & NOT_COMPATIBLE & INCONCLUSIVE & SUSPECTED & GUILTY;
- A9= NOT_EXCLUDED & NOT_COMPATIBLE & INCONCLUSIVE & NOT_SUSPECTED & GUILTY.

The resulting probabilistic constraints are:

- $P(\varnothing) = 0$ $P(\mathrm{A1}) = 0$ (this is strictly speaking not really a numerical constraint; rather, it is a consequence of the assumed logical constraint);
- $P(\mathrm{A8})+P(\mathrm{A9}) = 0.5\ (P(\mathrm{A6})+P(\mathrm{A7})+P(\mathrm{A8})+P(\mathrm{A9}))$;
- $P(\mathrm{A4})+P(\mathrm{A8}) = 0.95\ (P(\mathrm{A3})+P(\mathrm{A4})+P(\mathrm{A7})+ P(\mathrm{A8}))$;

with

$P(\mathrm{Ai}) \geq 0$, i=1,...,9,

and

$P(\mathrm{A1})+P(\mathrm{A2})+P(\mathrm{A3})+P(\mathrm{A4})+P(\mathrm{A5})+P(\mathrm{A6})+P(\mathrm{A7})+P(\mathrm{A8})+P(\mathrm{A9}) =1.$

The assessment can be seen as the premises. Based on these premises, the conclusion of interest, namely (GUILTY given (SUSPECTED and COMPATIBLE)), is unfortunately vacuous: in fact, by coherent extension, any probability value on this conclusion inside the unit interval [0,1] is coherent, i.e.,

$0 \leq P(\text{GUILTY} \mid (\text{SUSPECTED and COMPATIBLE})) \leq 1$.

Thus, the conclusion that a person is guilty given his/her DNA profile matches with the one found on the crime scene and that the person is among the suspected people is not warranted. This speaks against common-sense intuitions that would have surely found such a person guilty. Note, however, that there is nothing wrong about such a conclusion. Indeed, the court cannot find a suspect only on the basis of a matching DNA result as guilty: that would be a decision based on insufficient evidence. Still, common people's trust in law authorities could decrease, if suspects are found not guilty because of insufficient evidence.

The main reason of such a vague result is because of the unexpected scenario of an innocent suspected subject with compatible DNA profiling. In fact, we always obtain the coherent extension

$$0 \leq P(\text{not\_GUILTY and SUSPECTED and COMPATIBLE}) \leq 0.05$$

that represents a rare, but anyhow possible, scenario where other elements should be investigated, like, e.g., the possibility of contamination during the DNA profiling procedure (for more on forensic uncertainty, see, e.g., Taroni, Aitken, Garbolino, & Biedermann, 2006).

PSYCHOLOGICAL FACTORS IN PROBABILISTIC REASONING

This section presents selected examples of experimentally well-documented psychological factors that can influence the rationality of social and individual probabilistic reasoning and probabilistic assessments. As mentioned in the introduction, the coherence approach to probability allows for finding out whether the initial assessment (i.e., the premise set) is coherent and if yes, how to propagate the uncertainty of the premises to the conclusion in a rational way. However, it does not tell us whether the initial assessment is *correct* in the sense that the events are well chosen, all relevant logical relations are made explicit, and that the probabilistic assessments are realistic. For example, if the user over- or underestimates the probability of being exposed to a certain virus and draws an inference about whether to take a vaccine, this inference is as good as its premise set, if the laws of probability are respected. Of course, also if the initial assessment is not coherent or the way how the uncertainty is propagated from the premise set to the conclusion is done in a wrong way, the inference cannot be correct. Coherence does not imply the correctness of the premises. However, if coherence is violated, then the inference about the conclusion cannot be a correct (remember: violating coherence means semantically that a Dutch book can be constructed). The rational justification of the premise set is therefore important and deserves attention.

Where do the probabilities of the premises come from? Your degree of belief may be derived from observed frequencies. The more often you observe that, for example, the train is delayed, the higher is your degree of belief that the train will be delayed. As an example of inherited degrees of beliefs, consider unpleasant food. While for a scavenger carrion is an important source of nutrition, humans are evolutionarily trained to avoid carrion. Indeed rotten food has a foul smell and is potentially harmful to the human body. This instant feeling of disgust prevents people from eating rotten food and naturally induces a high degree of belief in better not to consume carrion. Thus, degrees of belief can be learned or genetically inherited.

Many cognitive fallacies and biases can influence how degrees of belief are formed. As an example, consider the so-called "availability heuristic" (Tversky & Kahneman, 1973; see also Gigerenzer & Goldstein, 2011). It states that your degree of belief in an event E depends on the ease with which realizations of E come to your mind. For example, if you want to evaluate the probability of an earthquake, you will evaluate the probability of an earthquake higher, when you remember instantly a happening of an earthquake. Likewise, if it takes some time to think and search your memory for an earthquake, you will assign a lower degree of belief.

Memory encoding depends on various factors. One is repetition: if an event is often perceived, it enters memory more easily and thus, can be retrieved faster. This is a justification why availability as a heuristic can often lead to an appropriate result. However, a heuristic is a rule of thumb and not a strictly deterministic universal law: it may often work but not necessarily always. Yet another factor which influences the formation of memory is emotional arousal (for the neurophysiological reasons see, e.g., McGaugh, 2000). For instance, learning about (the wrong) claims that children develop autism because of MMR vaccination is emotionally disturbing, especially for concerned parents who do not know that such claims are just fake news. Because of the high emotional arousal associated with these claims, such wrong ideas enter easily memory and are instantly retrievable: immediately the (wrong) story about the development of autism after being vaccinated is retrieved from memory and vaccine hesitancy results. This effect is even strengthened when parents who believe in a wrong relation between vaccination and autism share their concerns with other naive and concerned parents. Then not only the emotional arousal but also the repetition of the story enhances consolidation in memory. Such mechanisms explain why fake news can spread like in a snowball system.

Spreading fake news can also be described by "dual process theories" of reasoning (see, e. g., Evans & Stanovich, 2013). Dual process theories assume that human cognition is characterized by two types of ontologically distinct reasoning processes.

Type 1 processes refer to intuitive reasoning and are supposed to be evolutionary old. They involve, for example, fast and autonomous processes ("heuristics"). Type 2 processes refer to reflective reasoning and are supposed to evolutionary young. They involve, for example, controlled, slow, and conscious thinking ("logic"). Given this distinction, unreflective fast forwarding of fake news (e. g., on social media) can be seen as an instance of Type 1 processes. Reflection, critical thinking, and systematic checks of the validity, objectivity, and reliability of some "news" takes time and instantiates Type 2 processes. Such Type 2 processes could stop spreading fake news. It is plausible to assume that, in the long run, heuristics for checking "news" (i.e., Type 1 processes) could evolve from Type 2 processes.

Yet another psychological factor that may influence the rationality of probabilistic inference was first described in the context of human logical (i.e., deductive) reasoning: the so-called belief bias (see, e.g., Ball & Thompson, 2018; Evans, Barston, & Pollard, 1983). The belief bias can occur when people are asked to evaluate the *logical validity* of an argument. The correct response would involve firstly to assume that all premises are true. Secondly, it should be systematically tested whether it is impossible that all premises are true and the conclusion is false. If it is clear that it is not possible to construct a model in which all premises are true and the conclusion is false, then the argument is logically valid. However, if it is possible to find at least one interpretation under which all premises are true but the conclusion is false, then the argument is not logically valid. Now, the belief bias occurs when the logical validity of an argument is assessed only by considering whether the conclusion itself is believable or not (irrespective of the premise set).

What does belief bias mean in the context of probabilistic reasoning under coherence? It means that instead of propagating the uncertainty from the premises to the conclusion, the degree of belief in the conclusion is assigned directly (without considering the probabilistic and logical information contained in the premises). Thus, if, for example, the conclusion itself is highly believable, then a high degree of belief is assigned. However, it is easy to imagine situations where it is actually highly relevant to consider the premises and make an inference based on them to find the lower and upper bounds on the conclusion in a rational way. For example, consider the presence of a rare disease as the conclusion. As the disease is rare, one would according to the belief bias, assign a low degree of belief in the conclusion. However, it could be that the premises contain information concerning circumstances which actually raise the probability of the disease in question. And imagine that indeed, the premises constrain the conclusion such that suddenly the probability of the disease is indeed high. Belief biases in such situations can cause actual damage as the need for necessary medical treatments can be overlooked easily.

Finally, it is important to note that the focus of this chapter is on the propagation of the uncertainty from the premises (the initial probabilistic assessments) to the conclusion (i.e., the target event). Thus, the aim is to obtain probabilistic knowledge about the conclusion in the light of the premises (and not some abstract properties like logical or probabilistic validity; see also Kleiter, 2018, for a discussion of this point and its relevance for the study of human thinking and reasoning).

CONCLUSION

This chapter explained theoretical and practical advantages of the coherence approach to probability in comparison to standard approaches, like Kolmogorov's theory of probability. By probabilistic analyses of selected examples, the authors illustrated how the coherence approach to probability can serve to enhance rationality in debates about current societal problems in two different domains: medical reasoning and legal reasoning.

However, the chapter also showed problems of reasoning under uncertainty, which go beyond the scope of coherence: the justification of the correctness of the premise set and selected psychological factors—like the availability heuristic or belief biases—which impact on the rationality of probabilistic representations and reasoning.

Since society is facing uncertainty on a multitude of domains and levels, the authors are convinced that applying coherence contributes to enhancing rationality in public debates and provides a useful toolkit in the struggle against fake news. The authors suggest that rational methods and tools for representing and managing uncertainty should become a key focus in public education: especially in the current age of fake news and information overflow on the internet key competences in dealing with uncertainty should be taught and acquired in modern society.

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KEY TERMS AND DEFINITIONS

Algebra: Mathematical structure of a set of events, which contains the tautology and which is closed under finite disjunctions and negation. An algebra is also closed under finite conjunctions by de Morgan's laws. If an algebra is closed under infinite disjunctions and conjunctions, it is called "σ-algebra" (read: sigma-algebra).

Argument: Linguistic structure consisting of the premise set (i.e., known or assumed information) and the conclusion (what is supposed to follow from the premises).

Availability Heuristic: The evaluation of the probability of an event is derived from the ease with which instances of the event are retrieved from memory.

Belief Bias: Whether an argument is evaluated as valid depends only on whether the conclusion is believable (irrespective of the premise set).

Coherence: A subjective approach to probability which means semantically to avoid Dutch books. Syntactically, coherence means the solvability of a specific linear system that reflects the existence of at least one standard probability distribution which is compatible with the initial probability assessment.

Conditional Probability: Degree of belief in a conditional which consists of the conditioning event (the "if"-part, i.e., a specific event which is assumed to be true) and the conditioned event (the "then"-part, i.e., what is considered under the assumption of the conditioning event).

Dutch Book: A hypothetical combination of symmetric bets, where the player or the banker can switch each other's bets, such that it will lead to a sure win (or a sure loss).

Fake News: Wrong information communicated as true information.

Probability Assessment: A numerical evaluation of uncertainty on a finite set of events, not necessarily endowed with any mathematical structure but interconnected by logical relations, like implications, incompatibilities, equivalences, etc.

Vaccine Hesitancy: A reluctance or refusal to be vaccinated or to have one's children vaccinated.

ENDNOTE

[1] Note that frequentist approaches to probability define probabilities by the relative frequencies obtained in the limit of large number of experiments. Since there is only one "experiment" for a single case, frequentist approaches are unable to deal with single case probabilities.

Section 3
Education and Policy

Chapter 9
Does Role Playing Improve Moral Reasoning's Structures in Young Children?

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ABSTRACT

This chapter presents a research on moral judgment with pre-school and first-year school children. This research promotes, through the use of mimes and role playing, the development of moral reasoning and its components such as Theory of Mind and Perspective Taking of the other. The authors wanted to develop in 5-year-old children the ability to understand the intent of the other in social interactions and moral judgment. According to the authors, if children learn taking into account the perspective of the others through role playing, they will improve their cognitive abilities involved in social interactions and will be more capable of developing Theory of Mind. This will lead them to adopt a more pro-social behavior. This research paves the way to new pedagogical perspectives by showing that developing mime, role playing, and argumentation with young children to explain conflict, impacts the "intention evaluation system", the theory of mind and system 2 which is involved in rational and controlled reasoning.

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INTRODUCTION

This chapter presents research on moral judgment with pre-school and first-year school children. The aim of this research project was to promote, through the use of role playing, the development of moral reasoning and its components, such as Theory of Mind and Perspective Taking. Our aim was to develop in 5-year-old children the ability to understand the intent of the other person in social interactions and moral judgment. We contend that if children learn to take into account the perspective of other people by role playing then they will improve their cognitive abilities involved in social interactions and will be more capable of developing Theory of Mind. This should also lead them to adopt more pro-social behaviors. Our research paves the way to new pedagogical perspective by showing that role-playing and argumentation with young children to explain conflict, has an impact on the "intention evaluation system", the Theory of Mind and system 2, which is involved in rational and controlled reasoning. It also promotes better understanding of social interactions and therefore better social adaptation.

Moral judgment is the process by which one defines and judges what is bad or wrong versus good or right, or ethical versus unethical as established by rational consensus in a social group. Moral judgment regulates social behavior (Malle, Guglielmo, & Monroe, 2012) and allows community life. Recent research on moral judgment claims that the structures within moral judgment rely on different components of which the most important are deontic reasoning, Theory of Mind (ToM) (Fontaine, Salvano-Pardieu, Renoux & Pulford, 2004; Salvano-Pardieu, et al., 2016), emotion and inhibitory control (Buon, Seara-Cardoso, & Viding, 2016). We are inclined to believe that these components are subdivided in two systems, one evaluating the action and its consequence, relying on deontic reasoning and emotion, and the other evaluating the intention of the actor and relying on ToM.

Theory of Mind and Perspective Taking

The concept of perspective taking is linked to the Theory of Mind, which refers to an individual's ability to infer the mental states of other people from the perception of their behaviors. ToM is the ability to represent one's own and attribute to others thoughts, beliefs, feelings, desires, and intentions to help to explain their behavior. This ability allows people to predict, to prevent, and to understand one's actions and those of others. It is a very important component of social cognition which plays an important role in the development of social interactions. In fact, a person

can communicate with others only if they are able to understand that other people have their own mental states and ideas or beliefs which are different from their own. The theory of mind concept was first developed by the ethologists Premack and Woodruff (1978) then by Wellman (1988, 1990) who proposed a developmental model. There are two philosophical approaches about the nature of the theory of mind: the "theory-theory" and the "simulation theory". According to the "theory-theory" (Deneault & Morin, 2007; Perner, 1991), the representations an individual attributes to his mental states and those of others are based on his knowledge and on what he retained from his past experiences. The child gradually builds his own theory of mental states according to his cognitive development but also by relying on the perception of his social environment. The "theory-theory" is based on the idea that people develop a theory to reason about others' minds. This theory would develop automatically and innately, even though it is based on social interactions. This theory is closely related to "social perception": the perception one has from others at different levels of verbal and nonverbal interactions, (physical aspect, facial expression, gestures, voice pitch…) and to the "attribution theory": the process by which people seek to explain the cause of behaviors and infer about another person's mental state from their theoretical knowledge.

According to the "Simulation theory" of empathy (Flavell, 1999; Gordon, 1996), people anticipate and understand the behavior of others by mentally simulating or imitating their behavior. It would be necessary to mentally simulate the other's behaviors in order to experience personally the other's mental state and get insight into what he has thought and felt. It means that the simulation behavior is intentional and takes into account emotion, i.e. the person should take emotion into account in order to mentally simulate the other's behavior. While there is a link between ToM and empathy, these two concepts are different. Empathy is mainly based on emotional perspective taking, while ToM refers to cognitive perspective taking (Hynes, Baird & Grafton, 2006). Cognitive perspective taking is considered as the main component of ToM. Indeed, to master ToM, children have to learn to take the cognitive perspective of others which stretches over five levels of growing complexity. Therefore, cognitive perspective taking is correlated to their cognitive development, which develops with age, (Howlin, Baron-Cohen, & Hadwin, 1999).

Simulation theory would rely on mirror neuronal action. Neurons are activated when actions are executed as well as when they are observed. Indeed, the same neuronal mirror system is activated when an individual is executing a movement and when he is looking at someone else making the movement. Previous studies have shown that mirror neurons in monkeys play a role in understanding an action. When

the action is watched the same group of muscles is activated in the individuals who act and, via mirror neurons, in the individuals who observe the action. Therefore, Umilta et al. (2001) conclude that mirror neurons are involved in the prediction of the action. Research on mirror neurons has been extended to emotions and feelings. Carr, Iacoboni, Dubeau, Mazziotta and Lenzi (2003) have shown that the same brain regions are activated when people imitate or observe emotional facial expressions such as happiness, sadness, disgust, fear, surprise or anger. Other researchers have shown that people feel pain affectively (Avenanti, Paluello, Bufalari & Aglioti, 2006), and others have shown that people feel pain physically when watching other people suffering (Singer, Seymour, O'Doherty, Kaube, Dolan, & Frith, 2004) and therefore conclude that the mirror neuron system is also involved in the sensory perception of pain. These researches suggest mirror neurons are involved in understanding others' actions and emotions and are therefore associated with empathy (Singer et al., 2004). If empathy, defined as the emotional perspective of others is automatically activated and seems innate as suggested by these researchers and therefore seems to be associated with system 1, what about cognitive perspective taking and ToM? Can we assume that ToM is associated with system 2?

The Dual System

Kahneman's (2003, 2011) dual process theory proposes that thoughts arise from two different processes or systems. These two systems, called system 1 and system 2, have different properties. System 1 is an implicit, fast, unconscious and emotional process allowing the execution of automatic and inexpensive operations whilst system 2 is an explicit, controlled, conscious and slow decision process, allowing the execution of expensive, serial cognitive operations, (Greene, Sommerville, Nystrom, Darley & Cohen 2001; Greene, Cushman, Stewart, Lowenberg, Nystrom & Cohen 2009). Implicit process and unconscious thoughts or behaviors usually take a long time to evolve whilst thoughts and actions or attitudes which are explicit, verbalized and conscious may change and evolve with education and social interactions.

System 2 is slow, explicit, controlled and will process information in small quantities. Unlike system 1, it depends on working memory and is influenced by the cognitive abilities of the person. For instance, the famous Trolley dilemmas (Thomson, 1985) are an example of how this dual system is involved in moral judgement. In the Trolley dilemma, an out of control trolley (train) is about to kill five people working on a railway track. The dilemma consists in deciding if one should condemn one man to die in order to save five others. In the first dilemma,

participants must decide if they want to push a man off a bridge to stop the trolley. In the second dilemma, they must decide if they want to pull a lever to divert the trolley to a different track where only one man is working and would be killed. In these dilemmas, two different judgements are reported according to the dual system: a judgement based on an automatic emotional process (i.e. the aversion to killing someone) and a utilitarian judgement based on a controlled cognitive process (i.e. killing one man would save five lives). While very few people agree that they should push a person to save five others, the majority of participants do agree to pull a lever to divert the trolley and sacrifice one person. According to Cushman, Young and Greene (2010), the difference between the two trolley dilemmas is due to the aversion to doing harm and being responsible for a crime. In the Footbridge "push" dilemma, the automatic emotional processes as well as empathy are straightforwardly engaged and condemn the action. In contrast, in the Sidetrack "divert" dilemma, the cognitive processes are more strongly engaged and the judgement is more utilitarian and rational (Cushman et al., 2013).

It has been proven that system 1, the more emotional and faster system, dominated most reactions when the participant had to push the victim from the bridge. By contrast, system 2, the more rational and utilitarian system dominated most reactions when the participant had to pull a lever to divert the trolley. In the latter situation the participant was not physically in contact with the victim and therefore could more easily distance himself from the emotion caused by his action, which allows him to think more rationally and take into account the positive intention of this action. Therefore, one can deduce that system 1 would be mainly used in situations where people base their judgments on consequences, especially leading to injuries since they are associated with emotion, unlike system 2, more rational, which would be mainly used to judge intentions governing the action.

If, as discussed previously, empathy is mainly the "emotional" perspective taking of the other and theory of mind (ToM) the "cognitive" perspective taking of the other, this would suggest that these two aspects of moral reasoning would be two different parts of a same system involved in social interactions. One could assume that these two aspects of social interactions: empathy and ToM, could be associated within a dual process: relying, to judge every action, on empathy triggered by observable damage, and on the ability to understand the thought of the other and his intent. This assumption is congruent with previous studies (Fontaine et al., 2004; Salvano-Pardieu et al. 2016; Buon, et al., 2016), and suggests an integrative model of moral judgment based on two main components: ToM and Deontic Reasoning. According to these authors deontic reasoning concerns obligation and duty, most often in relation

to ethical or moral actions, and refers to the knowledge of the social rules (what is allowed and forbidden in a given society), which would enable a judgment based on the evaluation of the outcome of the action. By contrast, ToM would enable a judgment based on the evaluation of the agent's intention. Buon et al., (2016) present a complementary model they named "ETIC" integrating three components of moral judgment: "Emotional arousal" ToM and "Inhibitory Control". The authors describe the role of these components within a dual system: based on the evaluation of the action and its consequences and on the evaluation of the intention. According to these authors emotion would be crucial in the evaluation of the action. Emotional arousal would increase the level of blame based both on the aversion of doing harm and on the emotional contagion in perceiving someone in distress, it would also increase with the aggressiveness of the action and the seriousness of the consequence. Therefore, we can assume that emotional arousal is directly linked with emotional perspective and with empathy. "Inhibitory control" would regulate the activity of the dual system. It would inhibit the emotional arousal and the negative evaluation of the action when the bad outcome is accidental, facilitating a judgement based on the intention and supported by ToM.

Moral Development

Children develop prosocial behaviors through social interactions, first with their families and then with their peers. Moral stages and cognitive levels are passed through during childhood as children mature from one moral stage to another every few years, with age and cognitive development. Around 2–3 years old children learn social rules, what is allowed or not, what is bad or good, and what is an acceptable way of behaving in a group. Smetana (1981) has proven that children are also able to distinguish between behaviors that violate simple social rules (not putting belongings in the right place) and those violating moral rules (hitting a child). As they grow up, children are more and more able to take the "cognitive" perspective of the other, to understand his thoughts, recognize and attribute "false beliefs", which means reasoning using Theory of Mind. This cognitive ability, crucial in social interactions, usually appears around 4–5 years of age. According to Wimmer and Perner (1983) and Gweon et al. (2012) ToM emerges gradually for most children between 6 and 9 years old and continues to develop through social interactions during adolescence and early adulthood (Valle, Massaro, Castelli, & Marchetti, 2015).

Theory of mind develops continuously throughout childhood and into late adolescence as the synapses in the prefrontal cortex, involved in planning, judgment and decision making mature. The development of ToM seems to be sequential and

derived from joint attention. One of the first skills mastered in relation to ToM is the ability to recognize that others have several different desires. Then, that they have different beliefs. Later, children are able to recognize that others have different knowledge and that they may have false beliefs. Finally, children are able to understand that others may hide their emotions. The value attributed to each skill, and the speed at which the child masters them, depend on his cultural background (Malti, Gummerum, Keller, & Buchmann, 2009). Indeed, in a high context and collectivist culture, people communicate in an implicit way depending on the context (tone, gesture, silence…) and rely first and foremost on their understanding of the context to set and adjust their social behavior. On the contrary, in a low context culture, people rely on explicit verbal communication and are more individualistic (Hall, 1976). This difference between high and low context cultures creates differences in logical reasoning (Yama, Manktelow, Mercier, Van der Henst, Do, Kawasaki & Adachi, 2010) and in ethical reasoning (Tsui & Windsor, 2001).

INTENTION AND CONSEQUENCE: THE "DUAL SYSTEM" OF MORAL JUDGMENT

Most researchers studying moral judgment agree that children and mostly young children judge social interactions according to the output/consequence of the action rather than on the intention of the actor (Piaget, 1932, 1969; Przygotzki & Mullet, 1997; Killen Mulvey, Richardson, Jampol, & Woodward, 2011; Rogé & Mullet, 2011; Cushman et al., 2013; Salvano-Pardieu et al., 2016). Recent research on children's moral judgment (Salvano-Pardieu, Oubrahim, Galvani, Kilpatrick & Combalbert, 2019) has shown that children are able to understand negative intentions of an aggressor and assign blame when their actions lead to an adverse consequence. Consequently, children do not blame the actor when no consequence occurs. When the consequence, such as an injury is accidental and the action is not perpetrated deliberately, children are able to take into account the intention of the actor by not blaming the action. However, children take the intention into account only when the magnitude of the consequence is low. When the seriousness of the consequence increases children under 10 years old focus on the consequence and blame more harshly accidental actions. They also focus on the consequence rather than on the intention of the aggressor when the action is deliberate but does not lead to a negative consequence. In this case, children do not blame the aggressor or do so only leniently. Therefore, these authors conclude that children can understand

the intention of the other but only under certain conditions. This result suggests that children at that age are still at a developmental stage and do not master the cognitive perspective taking of other involved in ToM. This result is congruent with previous studies. According to Killen et al. (2011), children understand that accidental actions perpetrated without negative intention do not deserve punishment because the actor did not intend a negative outcome. Children with less developed cognitive perspective taking abilities, and weaker "false belief" attribution: i.e. children with weaker ToM capacities were also those who blamed others the most for accidental actions. This research confirms that the cognitive ability to understand the intentions of an individual within social interactions develops with age. This ability is crucial to understand others and set and adapt appropriate social behaviors. The question arises therefore whether educational activities could promote these cognitive abilities within young children to improve their understanding of social interactions and their prosocial behaviors.

Role Playing

As previously mentioned, the simulation theory states that to anticipate and understand the behavior of another, one has to mentally simulate or imitate his behavior. Therefore, playing with others and imitating their behaviors will help to develop social and cognitive skills, such as ToM. Imagination would play an important role in moral development. Paul (2014) defends the idea that most processes that assign moral values can be modified by experience, but not by the acquisition of abstract knowledge. Imagination can transform abstract facts into "virtual" experience, close to the real experience, and therefore would allow these moral processes to evolve (Barron, Dolan & Behrens, 2013; Gershman, Markman & Otto, 2014). Consequently, active learning such as theater or role playing will promote children's cognitive, moral and social development. Indeed, several educational research studies have confirmed that theatrical practice improves personal and social development (Way, 1967; Heathcote, 1984; Ryngaert, 1991) as well as moral development (Neelands 1990; O'Neill, Lambert, Linnell & Warr-Wood, 1990). Finally playing theater helps typically developing children with or without intellectual disabilities to understand and better respect human rights (Meirieu, 1996).

According to Ancelin-Schützenberger (1995) role-playing games have many benefits. Role-playing games are an educational learning tool, a tool for social interaction and a verbal and nonverbal expression tool. Role playing involves active learning, which makes learning fun, enjoyable and suitable for children.

Role playing helps develop motivation and a better understanding of one's own and others' behavior, and encourages adopting more prosocial behaviors. In addition, role playing develops imagination and creativity as well as cognitive perspective taking of others. Patin (2005) presents three essential aspects of the role-playing game: the experience which refers to the Piagetian concept of constructivism, the group which refers to the dynamic between members, and the game itself which refers to the symbolic. These three components occurring together in role playing explain its efficiency. By playing others' role, adopting attitudes or behaviors that are not his own, the child learns how to deal with new social situations. By playing a role, the child takes the perspective of the other and conversely is himself seen through the eyes of the other person. Taking the role of others helps to better understand them. Seeing oneself from the others' perspective enhances the perception of oneself and the sensitivity to others, developing a better understanding and better perspective taking. Following these findings, we assume that if children learn to take into account the perspective of others through role playing, then they would improve the cognitive skills involved in social interactions and would be more able to develop ToM. In moral judgment ToM is mainly observed in the way one judges the intention behind an action. Indeed, being able to understand the person's motives, the reasons of his action, if the action is deliberate or accidental, and if the person acts with a good or bad intention depends on having a good theory of mind. If, as previously noted, the structure of a dual system can be applied to moral judgment with the "action evaluation system" based on emotion and deontological reasoning, and with the "intentional evaluation system" based on ToM, then developing ToM i.e cognitive perspective taking via role-playing game activities with young children should lead to them developing moral judgements that are more focused on intention than on consequences.

The Experiment

In order to test this assumption and the impact of role-playing game activities on moral judgment of young children we ran an experiment. Three tests, staggered over the school year, were run with 50 volunteers: typically developing preschool children of 5 years old. Children were all registered in typically French preschool classes, the class just before "reception class". In the first individual test, children listened to 12 short stories about interactions between two children. For each story, they had to blame the aggressor by choosing the blame intensity on a scale from "0" no blame to "16" the highest blame.

The children were provided with a color scale with 16 intervals ranging from green to yellow, orange and red. Recent research has shown that children find it hard to use a scale with more than 5 levels (Mellor & Moore, 2014). So, to facilitate the use of this scale, above the intervals were five colored smileys (dark green, pale green, yellow, orange and red) indicating to the participant the level of blame according to the graduation of the scale. The green intervals were near "0" no blame (smiley with a smile) and the red intervals were near 16 "very severe blame" (unhappy smiley). The experimenter explained to the children how to use the scale. The experimenter also explained to the children the intensity of the blame according to their experiences at school or at home when they are punished for doing something wrong. Each child was told that they had to answer on the severity of the blame they would like to give but not on the kind of punishment. The experimenter ensured the child understood how to use the scale before starting the experiment.

The 12 stories presented 3 different factors: the *Intention* of the actor was either 1) deliberate or 2) accidental (intent was absent), the *Consequences* of the action which were either 1) negative or 2) absent, and the *Aggressiveness* of the action which could be either 1) low [push], 2) medium [punch], or 3) high [stab]. In the low level of aggressiveness, two children push each other either deliberately or by accident and the consequence was a fall followed or not by a bruised knee. In the medium level of aggressiveness the deliberate or accidental action was a punch in the face and the consequence was a broken nose. In the highest level of aggressiveness the action perpetrated deliberately or not was a stab in the leg and the consequence was a deep wound. For each level of aggressiveness four situations were presented in the stories to the children: "intentional harm" situation (the character acts with bad intent and his action leads to a bad consequence), "attempted harm" (the character acts with bad intent but his action does not lead to a bad consequence); "accidental harm" (the character acts accidentally but his action leads to a bad consequence) and "no harm" (the character acts accidentally and his action does not lead to a consequence), as according to previous researchers (Fontaine, et al., 2004; Salvano-Pardieu, et al., 2016).

During the second test the children, in small groups of 5 or 6 participants, had to play the role of the characters of the same 12 stories of the first test. Each story was read to the children and then the children had to explain the story. Two children chose one character of the story and played the scene on stage. All the children played all the stories in turn. During the play between the two actors, the other children watched their young fellows and commented the actor's play. For example, when the attitude of an actor did not fit with the character's intention described in the story,

the spectators asked their fellow actors to resume the play in order to adjust their attitude with the profile of their character. Thus, children learned to understand the perspective of the others and to understand their thoughts and social attitudes in playing the role. After having played a story, children individually had to judge the character and to decide the level of blame they wanted to assign by ticking a point on the scale between "0" and "16". After this individual phase a collective phase started. In this collective phase, setting up a socio-cognitive conflict, each child had to explain to the others the level of blame he assigned to a character. Each child had to argue and to explain his point of view to the others as well as to answer questions from his fellows and from the experimenter. The experimenter's questions led the children to reflect about the meaning of the character's actions and intentions. Children had to listen to each other and if they wanted to they could change their level of blame by ticking a new point on the scale. In this collective phase the same scale was used by all the children, and they could compare their selected point on the scale with the selected points of the other children. So, they blame the main character of each story by justifying their choice and comparing it with the points of view of the other children. A few months after the second test the children took part in a third test which was individual and held in the same conditions as the first one, with exactly the same stories.

Results

Test 2 being a training phase, only the results of the first and the third test are presented.

A 2 Test (first vs. last) x 3 Level of Aggressiveness of the action (Story): (Push vs. Punch vs. Stab) x 2 Intent: (with vs. without) x 2 Consequences: (with vs. without) ANOVA was conducted on the entire sample of participants. In this "repeated measures" ANOVA, Test, Level of Aggressiveness of the action (Story), Intent and Consequence were within-subjects factors. On average, in the first test, children blame "intentional harm" the highest and "no blame" the weakest. They blame "accidental harm" more harshly than "attempted harm".

As shown in Figure 1, in the "intentional harm" situation, when the outcome of the action leads to an adverse consequence and the intention is bad the children blame the agent much more harshly than in the other situations. The blame, averaged across the three levels of aggressiveness, is the highest ($M = 13.4$). By contrast in "no harm" situation when the action is accidental and does not result in a negative outcome, the level of blame, averaged across the three levels of aggressiveness is the lowest ($M = 2.9$). In the "attempted harm" situation, where the agent's intention

Figure 1. Results of the 5 year-old children to the first test, mean and standard error for the four situations "intentional harm", "attempted harm", "accidental harm" and "no harm" and the three levels of aggressiveness of the action: Low: "Push" resulting in a bruise knee, Medium: "Punch" resulting in a broken nose and High: "Stab" resulting in a deep wound in the leg.

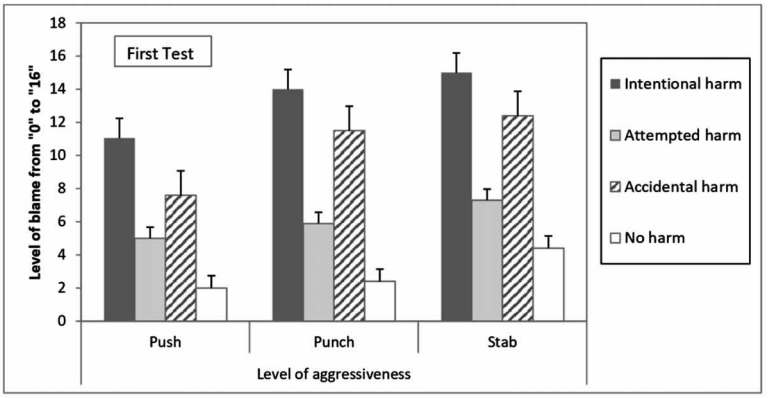
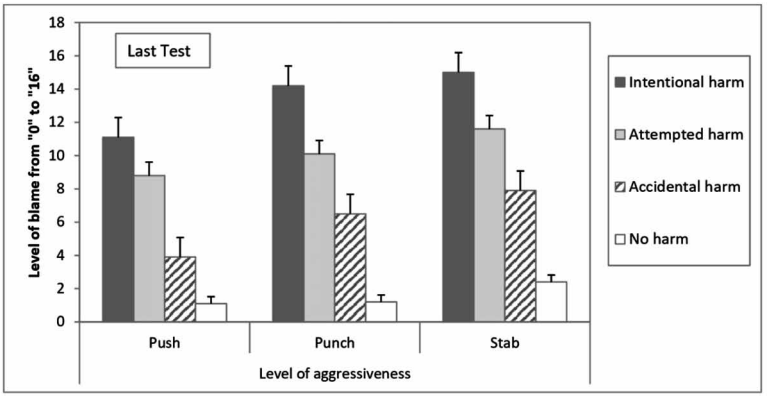


Figure 2. Results of the 5 year-old children to the last test, mean and standard error for the four situations "intentional harm", "attempted harm", "accidental harm" and "no harm" and the three levels of aggressiveness of the action: Low: "Push" resulting in a bruise knee, Medium: "Punch" resulting in a broken nose and High: "Stab" resulting in a deep wound in the leg.



is bad but does not result in an adverse consequence, on average, children blame leniently the agent (M = 6.1) whilst they blame much more harshly the "accidental harm" situation in which there is no bad intention and the action is not deliberate

but leads to an adverse outcome (M = 10.5). This difference, between attempted harm (M = 6.1) and accidental harm (M = 10.5) situations, averaged on the three levels of aggressiveness, is statistically significant [F (1, 49) = 39.33; p < .0001]. In addition, children blame more severely the high and medium levels of aggressiveness, the stab and the punch in the face than the low level of aggressiveness, the push.

As shown in Figure 2, after the collective role-playing phase, children have changed their moral judgments and focused their blame more on the actor's intention than on the resulting consequence. The interaction between the factors: Test and Intention is statistically significant. Indeed, the difference in the value of the intent between the first test (Intent: M= 9.7; No intent: M = 6.7) and the last test (Intent: M = 11.8; No Intent: M = 3.8) is statistically significant, [F (1, 98) = 63.89; p < .0001]. In addition the interaction between the factors: Test and Consequence is also statistically significant. In the last test children give less weight to the consequence than in the first test. This difference regarding consequence between the first test: (Consequence: M = 12.0; No consequence M = 4.5) and the last test (Consequence: M = 9.8; No Consequence: M= 5.9) is statistically significant [F (1, 98) = 48.48; p < .0001].

In "intentional harm" the level of blame is the same for both tests and remains the highest, as children did not alter their judgments. In the "no harm" situation, a similar result is observed in both tests, with the lowest overall level of blame attributed, though children blame slightly more leniently the perpetrator in the last test, mostly in the "Stab" story. Moreover, contrarily to the first test, after the role-playing game, children blame on average, much more harshly the intention of the agent in "attempted harm" (M = 10.2) than in "accidental harm" (M = 6.1) situations, and therefore take more intention than consequence into account. This difference between the main blame in these two situations is statistically significant [F (1, 49) = 28.19; p < .0001]. Finally, likewise the first test, children blame more harshly the highest and the medium level of aggressiveness.

The difference in moral judgment observed between the first and the last test confirms that the cognitive perspective taking of the other can be learned through role-playing games.

The First Test

The first test shows that children of 5 years old focus their judgment on the consequence of the action, since they blame accidental harm without bad intention more harshly than attempted harm with bad intention. This result is congruent with

previous findings on moral judgment (Piaget, 1932; Przygotzki & Mullet, 1997) that reported that children, and especially children under 10 years old, take into account the consequence of the action that is objective and tangible rather than the intention that is less visible and requires taking the cognitive perspective of the other person and achieving ToM. It also confirms that ToM and therefore taking the cognitive perspective of the other person which rely on ToM, is not entirely developed in the children we studied. These cognitive structures, even if they emerge around 4–5 years of age (Wimmer & Perner, 1983), need time to develop and to allow children to focus on the intent when judging social interactions (Valle et al., 2015).

This result also confirms the assumption of a dual system: "action-based evaluation" system and "intention-based" evaluation system involved in moral judgment. These two systems would have different speed of development and would reach their maturity at different times. For example, "action-based evaluation" system involved in judgment of the output of the action would be activated and efficient early in childhood, since 5-year-old children judge on the basis of the consequence of the action. The assumption that this "action evaluation" system relies on deontic reasoning, as suggested by Fontaine et al. (2004) and Salvano-Pardieu et al. (2016), seems congruent with this result since the young children questioned during the collective interaction and the role-playing phase knew the social rules, and were able to explain them to the others. They also knew what is allowable or forbidden, right or wrong, and which behavior deserves punishment in their family and at school. Finally, the result is congruent with Buon et al.'s (2016) model which states that emotion is a crucial component of the "action evaluation" system. Indeed, when the aggressiveness of the action increased, the blame assigned by the children increased but especially with the presence of a consequence and mainly in the "accidental harm" situation. This seems to confirm that children express an emotional arousal when the seriousness of the consequence increases. Empathy could explain this emotional sensitivity. Therefore, one could assume that "action-based evaluation" system in moral judgment is associated in reasoning process with system 1: fast, emotional and spontaneous.

The Last Test

The result of this study shows that children as young as 5 years old can judge the degree of blame according to the intent of the actor when they have been trained through role playing to take the cognitive perspective of the other, and to understand his intention. Indeed, in the last test the moral judgment of the children had evolved.

On the one hand the blame assigned in "intentional harm" and "no harm" situations still remain the same, on the other hand the blame assigned in "accidental harm" and "attempted harm" has been modified. While in the first test children blame "accidental harm" more than "attempted harm" the opposite is observed in the last test. After the role-playing intervention the children took into account the intention of the agent and blamed more leniently a consequence without bad intent than a bad and deliberate intent even though no consequence occurs. This result shows that after the role-playing phase, children understand the cognitive perspective of the other and take into account the intention of the character in the different stories when apportioning blame to his action. In addition, children after the role-playing phase become more concerned by the level of aggressiveness of the action. They blame harsher the medium and high levels of aggressiveness than the low level not only in the stories with consequence such as "accidental harm" but also in stories with intention such as "attempted harm".

This result is congruent with the assumption that "intention-based evaluation" system involved in moral judgment depends on the ToM and on the cognitive perspective taking abilities. These abilities develop later than deontic reasoning but our results indicate that they can be improved at an earlier age with training in social interactions. As shown in the results, role playing and socio-cognitive conflict based on debate and argumentation are efficient to develop the cognitive perspective taking of the other and the understanding of his intention. This result is congruent with the assumption that "intention-based evaluation" system in moral judgment is related to system 2: a slow, rational and explicit system. Even though some social abilities are based on innate components such as emotion and empathy observed in system 1, others are acquired, based on the education and experience. Indeed, even though behaviors like joint attention present early in life and are potentially considered as precursors of the theory of mind, these behaviors need to be encouraged and developed through education and social experiences. This result is congruent with previous studies that show that young children have skills to communicate and to infer the thoughts of other people before 5 years of age (Karniol, 1978; Smetana, 1981; Killen et al., 2011) but these social skills developed progressively during childhood (Wimmer & Perner, 1983; Gweon et al., 2012) and carry on developing with social interactions during adolescence and the beginning of adulthood (Valle et al., 2015).

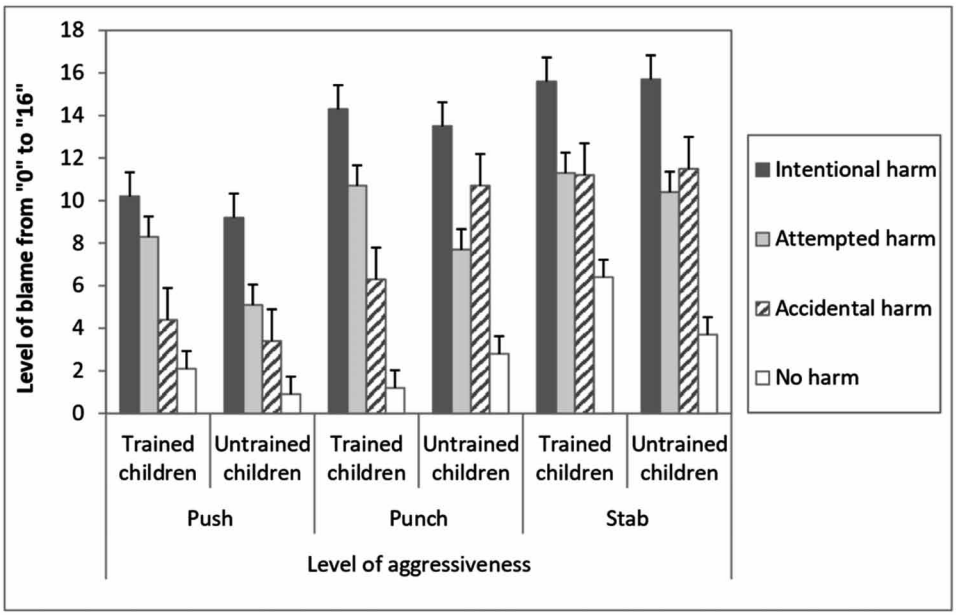
Learning Perspective Taking of the Other

Our study showed that role playing allowed children to enhance their understanding of the other person's mental state. Indeed, in the last test, after role-playing game training, children blamed the intention more than the consequence. Focus on the intention rather than on the consequence confirms that children were able to take the perspective of the other and to use this cognitive knowledge in a decision process to attribute blame accordingly. The improvement of cognitive abilities sustaining ToM and the perspective taking confirms previous results highlighting the interest of role-playing games in social interaction development (Way, 1967; Heathcote, 1984; Ryngaert, 1991) and in moral development (Neelands, 1990; O'Neill, Lambert, Linnell & Warr-Wood, 1990; Meirieu, 1996). It also confirms, in congruence with the "simulation" theory that to understand the other person one has to mentally simulate or imitate his behavior, and this is made easier when the person is made to play the role of the other person. Furthermore, this result confirms that processes assigning moral values can be modified by experience (Paul, 2014). In our experiment the last test occurred 2–3 months after the role-playing training session and although children develop cognitive perspective taking skills and were able to transfer these new cognitive skills in judgment of blame, it was not certain they had integrated these new skills on a long term basis. Therefore, we ran another test one year later to study the evolution of moral judgment by comparing the importance given to intent by children who had received role-playing training a year earlier with children who had not done any role-playing. This test included 35 children of 6 years old: 12 children had taken part in the experiment the year before, and 23 had never participated in the experiment. This test was held in the same conditions as the first one, with exactly the same stories.

One Year Later

Figure 3 shows the result of trained children who had taken part in the experiment one year earlier and the result of untrained children who took part in the experiment for the first time. On average, across the three levels of aggressiveness, trained children focus their blame more on the actor's intention than untrained children. The interaction between Test and Intent factors is statistically significant. Indeed, the difference on the value of the intent between trained (Intent: M= 11.7; No intent: M = 5.3) and untrained children (Intent: M= 10.3; No Intent: M = 5.6) is statistically significant, [$F(1, 33 = 3.95; p < .05$]. In addition, the interaction between Test and

Figure 3. Results, one year later, of the 12 trained children and 23 not trained children who participate in this experiment for the first time, for the four situations "intentional harm", "attempted harm", "accidental harm" and "no harm" and the three levels of aggressiveness of the action: Low: "Push" resulting in a bruise knee, Medium: "Punch" resulting in a broken nose and High: "Stab" resulting in a deep wound in the leg.



Consequence is also statistically significant. Trained children give less weight to the output of the action (Consequence: M = 10.3; No consequence: M = 6.7) than untrained children (Consequence: M = 10.8; No consequence: M = 5.1). This effect of the training on the consequence is statistically significant [F (1, 33) = 7.91; $p < .01$].

The result also shows a significant interaction between the three factors: Test, Intention and Levels of aggressiveness. Indeed, the difference between trained and untrained children according to the intent of the actor and the different levels of aggressiveness is statistically significant [F (2, 66) = 6.57; $p < 0.01$]. When the aggressiveness of the action is low (the Push story) and the consequence is not serious (a bruised knee), trained and untrained children have comparable results, they are able to take the intention into account and blame harsher "attempted harm" than "accidental harm", this result is emphasized with trained children. This result

confirms that children of 6 years old are at a developmental stage of ToM and are able to take into account the intent of the other when the consequence is low. By contrast, when the aggressiveness of the action is medium or high the result between trained and untrained children diverges. In the medium level of aggressiveness, a punch resulting in a broken nose, trained children take intent into account and blame "attempted harm" more severely than "accidental harm" while the opposite is observed with untrained children. The untrained children focus on the consequence and apportion blame according to it rather than to the intention of the person. In the highest level of aggressiveness–the stab leading to a deep wound in the leg–trained children blame "attempted harm" and "accidental harm" at the same level, whilst untrained children are more focused on the bad consequence and blame slightly more severely "accidental harm" than "attempted harm". Finally, on average, the difference observed between trained and untrained children is not statistically significant in both: "intentional harm" [$F(1, 33) = 0.85$; NS] and in "no harm" [$F(1, 33) = 1.41$; NS] situations.

This result confirms that through role-playing activities the children learned to take into account the cognitive perspective of the other person. They developed cognitive skills allowing them to understand the intention of the actor in social interactions. These cognitive skills were still apparent a year later, providing evidence that ToM and perspective taking are acquired abilities which developed through education and even more with role-playing, which we believe helped young children to leave the egocentric stage.

CONCLUSION

This research opens up new pedagogical perspectives by showing that role-playing and argumentation with young children to explain conflict has an impact on the "intention-based evaluation system". Unlike "action-based evaluation system" the evaluation of the intention depends on theory of mind, still developing during childhood. This result is congruent with recent research (Salvano-Pardieu et al., 2019) and suggests that the system involved in the evaluation of intention would be linked to system 2 – involved in rational and controlled reasoning. The neurological structure of this system would develop with experience, but mostly with active learning and cognitive stimulation based on debate, imitation and role playing. Role-playing allows children to leave the egocentric stage and to develop ToM: i.e. cognitive perspective taking skills to understand the viewpoint of the other

person. As a result, children as young as 5 years old better understand the intention of the actor when they have to judge social interactions. This better understanding should lead to more prosocial behavior and reduce conflict between young children. Finally, to further investigate the impact of role-playing on the development of the cognitive structures of ToM, new experiments should be developed with different actions involving the Theory of Mind and the perspective taking of others that can be compared with our results with moral judgment.

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Chapter 10
From Analogical to Analytical Thinking and Back:
The Adaptation of Teachers' Reasoning to Complex Situations

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ABSTRACT

This chapter shows the importance for teachers to enter into a truly reflexive activity and to make it the main aspect of their professional activity. The author describes ways teachers can regain control over the activity of thinking and adapt their modes of reasoning to educational situations by developing control over the transition from system 1 to system 2. The aim is to consider the conditions for developing decision-making procedures, both reflexive and collective, when faced with complex situations (particularly crises), based on a deliberation rooted in a logic of inquiry.

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INTRODUCTION

Teachers, teacher trainers, public policy makers and to a certain extent academics agree on the following: in the past few decades, or even years, the world has radically changed and so have the children and adolescents in the care of schools. Social networks, globalization, and increased access to information have radically transformed students. The educational system is facing new challenges, and we can no longer teach today as we used to. We have to think in a different way.

This thesis is as simplistic as it is attractive. Have the students changed radically? No. The means of communication they use and the information they can access may have changed, but students still have two arms and two legs, and more deeply, they are still human subjects whose identity, interactions, and the way that they relate to others and the world are organized according to the same anthropological invariants that prevailed 10, 20, 100, 1000 years ago. What has changed is that education practitioners understand these invariants less and are increasingly less familiar with them and less able to think about and *with* them.

Can we no longer teach today as we used to? This depends on who the "we" refers to. If we are talking about teachers who practice the so-called "traditional" teaching methods, it is certainly not possible for them to continue to teach in this way. However, that does not mean that this traditional way was relevant yesterday. The frontal, magistral methods are iniquitous as much today as yesterday, but this may be more obvious today than yesterday. As for *pedagogues* in the strong sense, these transformations (in the world, the resources in terms of information, the means of communication) simplify their work. More than ever, they can implement teaching methods that alternative pedagogies invented decades ago. Yesterday, they did not deliver knowledge from their podium, and they invited students to seek it out in the world. For them, social networks and new means of communication are a godsend.

Do we have to think in a different way? We just have to think, quite simply. That's where the problem lies, at least in France. Teaching is wrongly considered as a technical, practical trade. We do not know if the profession has become less intellectual, but we make that assumption. Today, the profession is described as determined by the implementation of purely technical gestures. The mass of teachers is not very educated and reads little. The training is practical. When theories are mobilized, they are mobilized too quickly, to simply justify recommended actions (best practices) according to an applicationist logic. In French pre-service training, "reflexivity" takes the form of the production of a research paper and practice analyses. However, most of the time, these strategies are mobilized in ways that reinforce the thoughtlessness that is characteristic of the teaching world.

Our purpose in this text is as follows: we seek to show the importance for teachers to enter into a truly reflexive activity and to make this reflexive activity (rather than tools, techniques, good practices) the main aspect of their professional activity—basically an intellectual activity. We would also like to describe the ways in which teachers can regain control over the activity of thinking and adapt their modes of reasoning to educational situations by developing control over the transition from system 1 to system 2. Or, using the vocabulary that we use more readily, borrowed from Peircean semiotics and logic, how they can regain control of their habits of belief or thought, of conduct, and of action. The aim is to consider the conditions for developing decision-making procedures, both reflexive and collective, when faced with complex situations (particularly crises), based on a deliberation that is rooted in a logic of inquiry.

DEFINING THE PROBLEM: TEACHERS' DECISION MAKING

To address these issues, we will focus on the way that teachers make decisions, especially when they have to deal with complex, in this case critical, situations. In our opinion, a situation is complex if it is determined by a large number of variables and if it raises questions that can only be answered by first producing a definition of the situation (Thomas, 1923, p. 42). By critical situation, we mean situations of verbal or physical violence but also situations of disagreement or tension, in particular all the situations in which students are considered to be guilty of "infractions". The observation of such violations potentially refers to situations in which the teacher perceives a discrepancy between, on the one hand, the behavior s/he expects from the student or which he or she considers expected by the institution, and on the other hand, the performance or actual behavior. In other words, situations in which a teacher makes judgments underlying his/her action and moral judgments based on norms and theoretical frameworks that s/he may or may not take the time to clarify for him/herself (See Pesce, 2015).

Thus, various situations can be considered as infractions: a student who does not have his or her school equipment, a student who refuses to work, a student who shrugs or frowns, a student who drops his or her rule, a student who makes a joke at the wrong time, etc.; even if none of these behaviors are formally prohibited by any regulation, they may lead to a judgment (as will be seen, in relation to an attribution of intent or character trait) that will eventually lead to a sanction.

It is therefore this type of judgment and decision making in professional situations that we are interested in here. First, we consider mechanisms at the individual level, which reflects the standard of teachers' decision making in many countries; in any

case, in France, the teacher in most cases produces judgments and decisions alone in her/his class. We will then consider how these judgments can be more reflectively produced by the teaching community. Our main interest is in the way that this passage from individual to collective decision making, associated with a passage from an immediate decision to a deferred decision, mediated by the group and by deliberation tools, becomes the occasion for change in the forms of rationality used. We therefore propose to explore the type of rationality that structures these decisions. In addition, we would like to question the theoretical tools at our disposal to study these processes of judgment and decision making.

Professional Anchoring and the Theoretical Framework

The way we analyze these phenomena is shaped by the theoretical framework that we mobilize and also by our professional background and the path that has led us to mobilize such theories.

Before becoming an academic, we were a teacher and educator in a particular context: that of "alternative" pedagogies (in French; one would be tempted to speak of progressive education when writing in English). We worked in an institution that considered rules, infractions and sanctions in radically different ways than those prevailing in "traditional" schools. This school was nothing like what one imagines a "liberal" school to be, one with a lax relationship to rules and sanctions. Many infringements were noted, and the students were often subject to sanctions. However, the acknowledgment of infringements and decisions on sanctions did not follow the pattern usually observed in schools. A teacher could never decide on a sanction alone. These decisions were always collective, involving all adults and students in the class or school. Sanctions were always taken in a deferred manner. Decisions on these sanctions were always taken after a deliberative process of adversarial debate. Above all, none of the alleged "offences" we evoked above existed: not working, not having your equipment, laughing, shrugging, making a bad joke—none of these was considered deviant behavior. However, the most important thing is that this institution mobilized forms of rationality that were in no way similar to those generally mobilized in other schools. In other words, the educators of this institution articulated what Kahneman (2011) popularized under the terms system 1 and system 2, according to logics that are not those of the traditional school.

In addition, as part of a research activity, we began to question these situations at a time when these notions of system 1 and system 2 were not yet truly present in the debate, even though Kahneman and his collaborators had long published work

that addressed these questions: work on intuitive judgment (Tversky & Kahneman, 1974; Kahneman, Slovic, & Tversky, 1982) and then on mobilizing the notions of "extensional *versus* intuitive reasoning" (Gilovich, Griffin, & Kahneman, 2002). We have therefore explored issues similar to those studied by Kahneman and his collaborators, but we have done so with reference to works in the long philosophical tradition of "intelligent habit" (Maine de Biran, 1799/1929; Ravaisson, 1838/2008; Merleau-Ponty, 1945/1962) and cognitive science (Lakoff & Johnson, 1980; Johnson, 1987; Lakoff, 1987; Gibbs, 2005).

Values, Morality, and Ethics: The Meaning of Experienced Situations

Theoretically, at least, the situations we are studying here (decisions on the recording of an offence and a sanction) do not raise moral questions, exactly in the same sense that a court or judge does not refer to morality but to the law. When a teacher imposes a sanction (or, when a school respects the principles of law, when the institution gives a sanction), he or she makes a decision about correspondences or objective discrepancies between expected and actual behaviors. Ethical reflection, or moral frames of reference, has intervened upstream in the production of regulations but has become transparent and implicit once the application of the regulations thus elaborated has arrived.

However, the moral issue is omnipresent in the judgments we are talking about here: what the student does is right or wrong, good or bad, in reference to an intention that is attributed by the teacher to the student. "Laughter", which is not objectively prohibited, is considered a sign of mockery or insolence towards the teacher. "Refusal to work" is a sign of the student's laziness. "Dropping one's ruler" results from the intention to disrupt the normal course of the class. Leaving your phone vibrating, when you have forgotten to put it in your locker or to turn it off, is a sign of disrespect for the teacher. In all these situations, system 1 intervenes, and it is this form of reasoning that functions (or, in our opinion, malfunctions).

In most situations in which the teacher notices an offence and sanctions a student, s/he does the following three things (one would be tempted to say one after another, but it is important to note that s/he does all three things at the same time): s/he attributes an intention to the student, makes assumptions about the moral characterization of that intention, and s/he categorizes the student's action or behavior as good or bad (See Pesce, 2011, 2013).

Our intention in this chapter is to distinguish moral judgment from a decision based on ethical deliberation and to associate this moral/ethical dyad with another dyad: system 1/system 2. To put it briefly, before developing this question, we

propose to distinguish moral judgments based on intuitive thinking (system 1) from ethical decisions based on extensive or reflexive thinking (system 2). The next step will be to describe how these two systems can be articulated in the context of the implementation of judgments that are, in all cases, ethical.

CONSIDERATIONS ON TEACHER REASONING

System 1 / System 2

Kahneman (2011, p. 21) defines systems 1 and 2 as follows: "System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control. System 2 allocates attention to the effortful mental activities that demand it, including complex computations."

System 2 takes over from System 1 when the latter is in trouble, when it is unable to solve a problem. The articulation between these two systems responds to a form of economic concern: "The division of labor between System 1 and System 2 is highly efficient: it minimizes effort and optimizes performance. The arrangement works well most of the time because System 1 is generally very good at what it does: its models of familiar situations are accurate, its short-term predictions are usually accurate as well, and its initial reactions to challenges are swift and generally appropriate. System 1 has biases, however, systematic errors that it is prone to make in specified circumstances" (p. 25).

Most decisions made by the teacher alone in his/her classroom rely on a form of automaticity that corresponds to system 1. These decisions are characterized by their rapidity and by the weak voluntary control described by Kahneman. These decisions, by mobilizing system 1, lead professionals to "jump to conclusions", to use an analysis proposed by Kahneman: "(…) it offers an apt description of how System 1 functions. Jumping to conclusions is efficient if the conclusions are likely to be correct and the costs of an occasional mistake acceptable, and if the jump saves much time and effort. Jumping to conclusions is risky when the situation is unfamiliar, the stakes are high, and there is no time to collect more information" (p. 69).

However, here, we have to make a slightly different analysis: the problem of the teacher who decides to establish an offence and punish it is not precisely in a "unfamiliar" situation. S/he is in a situation that is precisely too familiar, whose meaning seems obvious to him/her. S/he has a prior definition of the situation,

which he/she initiates without effort. This economy of effort is made possible by the definition of the situation that is already available and leads him/her to make the type of moral judgment and decision that we study in this chapter. In other words, and to introduce the following, the teacher mobilizes habits of belief, of conduct and of action that structure his or her judgment and decision, and it is these habits that are potentially the issues.

A difficulty lies in the difference between the situations that Kahneman analyzes and the situations we are interested in, precisely because we are studying complex situations. Kahneman's research interests include statistical judgments and the biases associated with these judgments. In many of the judgments he analyzes, there is a good answer. The judgment made by the individual may thus be erroneous, according to a binary logic: there is a good answer (for example, there is more of a chance of finding the letter K in third place in a word than in the first letter of that word—Kahneman, 2011, p. 11), and the individual may be led to suffer from a bias and fail to give that good answer.

In professional situations involving teachers, it is much more difficult, if not irrelevant, to speak of erroneous judgment. One could of course propose the following interpretation: if a behavior is not explicitly described as prohibited by a regulation, sanctioning it is the result of an erroneous judgment. However, such a statement makes no sense. Any regulation, when applied to real situations, presupposes an interpretation. Judging a conduct as acceptable or reprehensible involves interpreting the spirit of the law, and this judgment is not true or false but more or less consistent with the intent of this regulation and the objective nature of the situation. Therefore, we do not seek to know whether teachers are right or wrong in producing this or that judgment. Our concern, along the lines of Peirce's pragmatist philosophy, is to understand the effects of these judgments and decisions.

Intention Attribution and Psychologization of Social Reality

When teachers are engaged in a classroom situation, they must synchronously perform a variety of tasks. When a critical situation emerges, they are forced to evaluate the event very quickly, to assign a meaning to it, and to make a decision about how to answer the question posed by the incident. Not only must they operate in an "analogical" mode, but they must also do so while experiencing "cognitive busyness". One can, along with Gilbert (2002, p. 168), describe how the teacher takes information that he or she considers relevant in the critical situation: "when we 'make an attribution' about another, we attempt to determine which of these factors—the person or the person's situation—played the more significant role in shaping the person's behavior".

Teachers, at least in the French context, are part of a pedagogical tradition that leads them to explain any school situations in the light of individual/psychological factors. Among the wide variety of the determinants of a school situation, success or failure, or crisis, it is above all these individual factors that are used to define the situation, both by teachers, students, and families: "(…) perceivers categorize or identify the actor's behavior ('Gee, my classmate sure is acting nervous'), characterize the actor in terms of enduring behavioral predispositions ('He must be an anxious sort of fellow'), and finally, correct these inferences with information about external influences on the actor's behavior ('Of course, the professor is really putting him on the spot, so maybe he's not such an anxious guy after all')" (Gilbert, 2002, p. 170).

By accompanying teachers in the field through methods that lead them to describe and analyze critical situations, we have noticed that it is precisely this correction mechanism that is broken in most teaching teams: they are surprisingly unable to take into account factors other than psychological ones. Everything can be explained by the subject's intentions or by stable dispositions—almost nothing is ever explained by situational factors. This inability may be partly explained, again following Gilbert (2002, p. 170), by the teacher's cognitive busyness at a time when s/he must handle these critical situations: "cognitive busyness disables the perceiver's ability to use information about aspects of the situation that might have facilitated or impeded a target's behavior".

However, this "busyness" does not explain everything: these reflexes of psychological explanation are still present in training situations in which the teachers have the possibility to defer the analysis, to tear themselves away from these immediate explanations, from this analogical mode, and to engage in a reflexive activity. Even when activating system 2, teachers do not manage to escape their habits of interpretation. Most of the time, a form of "naive morality" characteristic of system 1, or the analogical mode, persists.

The Limiting Effects of Exclusively Psychological Explanations

The psychological interpretation framework (the attribution of internal causes to critical situations experienced in the classroom) is of course a useful resource for educational work. Our intent is not to suggest that these factors do not exist or that they should not be taken into account. However, when this explanatory framework is the only one used, two main problems arise.

The most obvious of these problems is that the teacher who relies solely on psychological explanations ignores, by definition, a set of pedagogical, situational, social and anthropological variables. Situational and pedagogical factors refer to

the set of choices made by the teacher but also by the school's management: choices relating to programs, classroom organization, course duration, classroom layout, and teaching methods. Social (and psychosocial) factors concern the composition of the group, its dynamics, and the interactions between subjects. Finally, there is a set of factors corresponding to anthropological invariants, making it possible to describe, for example, issues related to *face* (Goffman, 1967), tension build-ups (Fracchiolla et al., 2013), phenomena relating to the need for recognition (Honneth, 1992/1995), and modalities for defining the situation in a school context (Woods, 1986, and more generally the contributions of school ethnography). Ignoring these factors simply means depriving oneself of powerful levers that would make it possible to transform school situations and act in critical situations, both in terms of prevention and treatment.

The second problem, corollary to the first, is the following: when teachers focus on internal explanations of critical situations, they choose to take into account the factors on which they have the least possible opportunity to act. While teachers can influence pedagogical and situational factors, they cannot transform what would constitute stable dispositions of the individual. They discard the parameters on which they could and should intervene and list explanations that are beyond their responsibility. It is a way of discharging oneself of all responsibility (the situation one created is not the cause of the crisis) and a very good reason not to try to act on this situation: we can wait for the specialists, the systems reserved for troubled students, to support the students who put us in difficulty.

Thus, by psychologization, we mean not the mobilization of psychological frameworks in the explanation of critical situations (since these frameworks are of course necessary), but a twofold process: on the one hand, the almost exclusive, or at least dominant, mobilization of these explanatory models; the illusion that the causes of crises are always internal to the subject and with this illusion the inability to act on external causes, which are the only causes over which teachers have any influence. This means believing that everything is happening "beneath the skin and between the ears" (Mehan, 1996).

This inability to consider classroom situations in a complex (Le Moigne and Morin, 2007), multireferential (Ardoino, 1993) way results in a series of situations which, from an external perspective, constitute a form of madness: teachers continue to implement, again and again, the same responses to critical situations. These responses (traditional forms of sanction, classroom exclusions, detention hours) do not work because they are based on erroneous definitions of the situations. However, these failures do not lead to challenging these answers: teachers continue to rely on the same explanations, to give the same responses, they continue to witness the failure of these responses, only to return once again to the same causal attributions. This is the thoughtlessness we were referring to above.

BEYOND AND BEFORE SYSTEM 1 / SYSTEM 2: THE PHILOSOPHICAL TRADITION OF "INTELLIGENT HABIT"

The Failure to Address this Problem Through Teacher Training

Neither the French education system administration nor the instructors in charge of teacher training are completely unaware of this problem. There is a fairly widespread awareness that teachers need to enrich the theoretical resources they have at their disposal to analyze situations.

Efforts are therefore made to inform (future) teachers that there exists a variety of theoretical frameworks for thinking about education, a variety of subject-matter that can help teachers or teaching teams have a better understanding of educational situations. Thus, in teacher training in France, psychologists, philosophers, sociologists, sometimes even (but more rarely) anthropologists are involved side by side (in addition to specialists in teaching disciplines). Teachers are "trained" through these different disciplines—or rather, to be honest, they are informed of the contributions of these different disciplines. Often in lectures, instructors discuss the great authors, the great currents, and the great theories. Interpretation frameworks are provided. Sometimes one even speaks of recognition, "face" problems, tension build-up, etc. In most cases, however, the time that can be devoted to these issues is so limited that teachers are not so much informed about the contributions of these disciplines as about their mere existence. These teachings are very compartmentalized. There are few opportunities to consider complex situations and conduct a multireferential analysis by mobilizing all these frameworks together.

The result is quite unconvincing. When we visit the classes of teachers who are nearing the end of their training and when we invite them to analyze a situation observed in the classroom, they continue to mobilize mainly explanations relating to the dispositions or personality of individuals. To put it simply, despite the teachings they received, their perspective on school situations has not changed. This can be easily explained: these views of classrooms and schools are based on a set of embodied theories, explanatory schemes that are habits of belief, conduct and action. It is a question of incorporated knowledge, immediately mobilized, in an analogical mode, and the lectures offered to teachers do not change anything about it. For the teachers engaged in actual school settings, it is always system 1 that works, and its propellant is always the same; it continues to be driven by the same theories. It is this notion of habit, which is consistent with the concerns of Kahneman and his colleagues (but which is part of a much older theoretical tradition) that we would like to focus on now to challenge this reality.

The Tradition of Intelligent Habit

There is a long philosophical tradition regarding "intelligent habit" and, more generally, the role of habit in human thought (Sparrow & Hutchinson, 2013). Maine de Biran (1799/1929) describes the paradoxes of habit, which at the same time allows the speed of judgment and makes us run the risk of error: "(...) habit can indeed make these movements more prompt and precise" (p. 108); "(...) in the most complex and at first the most laborious reasoning, after frequent repetition, the beginning and the end seem to touch and to connect directly with each other, so unsteady has the intermediate chain become, so great are the readiness and facility with which it is performed" (p. 193). The subject "jumps to conclusions" (a process described by Kahneman – see above), from the observed situation to the attribution of meaning to this situation, without going through the different stages of reasoning: "it is signs of habit which, abstracted in some manner from familiar perceptions and transferred to the midst of new and quite different forms, give to our first judgments a deceptive generality and begin to open of error with that of knowledge". The mobilization of habit leads us to believe, wrongly, that the definition of the situation is given by the situation itself, that it is obvious, transparent.

A few decades later, Ravaisson (1838/2008) analyzes the same paradoxes but insists on the intelligent dimension of habit, where its dangers prevailed in Maine de Biran's analysis: "although movement, as it becomes a habit, leaves the sphere of will and reflection, it does not leave that of intelligence. It does not become the mechanical effect of an external impulse, but rather the effect of an inclination that follows from the will" (p. 55).

Merleau-Ponty's phenomenological perspective (1945/1962) is in line with this tradition and allows us to consider the synchronicity of perception and interpretation: "Perception becomes an 'interpretation' of the signs that our senses provide in accordance with the bodily stimuli, (...) a 'hypothesis' that the mind evolves to 'explain its impressions to itself'. But judgement also, brought in to explain the excess of perception over the retinal impressions, instead of being the act of perception Itself grasped from within by authentic reflection, becomes once more a mere 'factor' of perception, responsible for providing what the body does not provide- instead of being a transcendental activity, it becomes simply a logical activity of drawing a conclusion" (p. 33). To activate a habit means, etymologically, "having a world" (p. 146), a world carrying meanings already there, ready to be mobilized for action: "The bench, scissors, pieces of leather offer themselves to the subject as poles of action; through their combined values they delimit a certain situation, an open situation moreover, which calls for a certain mode of resolution, a certain kind of work" (p. 106).

Charles Sanders Peirce's semiotics and phenomenology make it possible to extend this analysis by distinguishing between habits of belief, conduct and action (see Pesce, 2018a, 2018b). Habits of interpretation are embodied theories, ready-to-use explanations, meanings that are ready to be applied to situations. Habits of conduct refer to tendencies to act in a certain way in response to certain types of situations. Habits of practical action consist of a series of gestures that structure these behaviors. Thus, the student who does not have his material is considered a lazy, or disrespectful student (habit of interpretation), an explanation that mobilizes a reaction, the process of exclusion from class (habit of conduct) organized around a series of concrete actions (habits of practical action).

Our own intervention work with teachers' teams could be described as structured around the transition from system 1 to system 2. However, because we refer to the contributions of the philosophy of habit, to Peircean semiotics and phenomenology, we describe this process differently: it aims to accompany the disembodiment of habits of belief, conduct and action.

Disembodying Explanatory Metaphors and Narrative Schematas

Varela theorized about embodied cognition in direct reference to Merleau-Ponty (Varela, 1999; Varela, Thompson & Rosch, 1991). His description of the couplings between subject and environment leads him to describe a coevolution of the elements of the system and to propose an interpretation of the modalities according to which a subject actualizes microidentities in microworlds, within which s/he acts out of habit, without having to resort to conscious thought. Like Merleau-Ponty, Varela rejects purely representational visions of cognition and, more specifically, the "traditional cognitivist research program" (p. 42) and its dualist and computational backdrop. This criticism is very generally relayed by the supporters of the principles on which we rely here: action and cognition are situated.

First, *cognition is situated*. For Suchman (2006), cognitive processes are deployed during the action itself and not only as part of an anticipatory activity aimed at establishing the plans that would then be implemented; more generally, cognitive activity is determined in its forms by the constituent elements of a situation; the notion refers more generally to the phenomenon of coupling analyzed by Varela.

Cognition is embodied. Shapiro (2011: 4) describes three common formulations of this thesis (I paraphrase here his analysis): the theme of conceptualization (concepts useful for understanding the world depend both on "having a body" and

on the "type of body we have"); that of "replacement" (cognition does not depend on the computation of symbolic representations, it can take place in systems that are neither dependent on representational states nor based on the computation of information); and the theme of "constitution" (the body is constitutive—it is not a simple cause—of cognition).

Cognition is distributed, a notion that takes up and extends the notion of situated cognition. For Hollan and his colleagues (2000, p. 176), "Cognitive processes may be distributed across the members of a social group; cognitive processes may involve coordination between internal and external (material or environmental) structure; processes may be distributed through time in such a way that the products of earlier events can transform the nature of later events". A classic example of distributed cognition is the use of handwritten notes during a calculation, with paper serving as a short-term memory, becoming one of the "places" where the cognitive process takes place. Theories of situated, embodied, and distributed cognition offer powerful tools for thinking about the implementation of system 1. They are part of the resources on which we rely to think about the disembodiment of habits of action (Pesce, 2014a).

SUPPORTING THE EMERGENCE OF NEW DECISION-MAKING PROCESSES

As we have pointed out above, it is not enough to present to future or current teachers, in an abstract way, theories that are alternative to those that they usually mobilize to transform the way that they will actually analyze critical situations. These new frames of reference do not replace embodied theories, those that they spontaneously mobilize in situations.

It often happens that teachers have the opportunity to move from an analogical approach (system 1) to an analytical one (system 2), getting out of the urgency of daily classroom life. This is the case in practice analyses, in which a method is supposed to make it possible to move from system 1 to system 2, from fast thinking to slow thinking. However, what we often see is that this transition from system 1 to system 2 does not lead teachers to abandon the psychological perspective mentioned above. Nor do they become able to mobilize psychosociological, sociological, anthropological theories to analyze lived situations. They do not have more insight into the aspects of the situation that they had previously overlooked. In other words, practice analyses allow them to describe their usual decision-making methods, to justify them based on their usual interpretation habits, often to reinforce them, before returning to the classroom to apply them again.

The Objectives of the Program: From System 1 to System 2 and Back

The continuing training programs we propose to describe here have several objectives:

- enable teachers, as a team, to disincorporate their habits of interpretation, conduct and action through a process of inquiry that constitutes a specific way of mobilizing what Kahneman would call system 2;
- allow teachers to appropriate, first in an analytical mode, these new ways of perceiving reality, these new explanatory models;
- allow them to then experiment in the field with these new models of explanation and then gradually incorporate them, making them into new habits that will be mobilized when, in urgent situations, they operate again in an analogical mode (or in system 1/fast thinking).

Before describing the continuing education approaches that interest us here, we will give a concrete example to help the reader better understand the significance of the transformation that these trainings are intended to bring about. We will give an example that seems to us very characteristic of the difference between a traditional (and harmful) conception of the child and education and a conception that seems to us to be specific to a number of alternative pedagogies: the difficult student *versus* the student experiencing difficulties.

In many critical situations in the classroom and because of the long-established psychological explanation habit, the reflex of many teachers when a student does not show the behavior expected of him or her is to consider that they are dealing with a disruptive or difficult student. This explanation is omnipresent among teachers but also in political and academic discourses. The pseudo concept of "disruptive student" is an obvious token of psychological explanation. This suggests that the critical situation is caused by individual factors and not by contextual or pedagogical ones. While the notion of a disruptive student is a typical example, others follow the same logic: the student with behavioral problems or the student with special needs. All contemporary discourses that support the "pathologization" of behaviors (Fances, 2013; Greenberg, 2013; Minard, 2013; Paris, 2015) and maintain the abusive medicalization of school failure (Morel, 2014) rely on this kind of explanatory schemes.

When we hear discussions among teachers who do not follow traditional pedagogies but intervene within the framework of alternative education, these discourses tend to disappear or are at the very least much more discreet. In similar situations, these

teachers tend to forget the question "what is wrong with this student?" They focus on the question "what is wrong with this situation, in the classroom, in my pedagogy, and what fosters this behavior or generates this difficulty?" In other words, they stop considering the child as disruptive or ill or disabled or difficult; instead, they see a student in difficulty, a student who is indeed handicapped, but handicapped by the situation that they or their institution has created. They stop wondering what is wrong with this student, what should change in him/her (something they can do nothing about apart from asking for care outside the classroom). Rather, they wonder what they will actually be able to change in their practices or in class organization. This second option perfectly sums up what a "pedagogue" is: he or she who, rather than rehashing the list of factors (which do not depend on him or her) that prevent him or her from doing his or her job, takes action to transform the variables over which he or she has control. Therein lies the difference between a non-pedagogue and a pedagogue, or to put it more radically, between a bad teacher and a good one. However, at the heart of the transition from one to the other is the ability to see the child as in difficulty rather than as difficult, a form of judgment incorporated into the situation and its perception that is part of a teaching ethos. It is precisely this passage from one metaphor (in the sense of Taylor, 1984) to another that we want to make possible for the teachers we accompany.

A Logic of Inquiry

We will mention some arrangements that are in line with the tradition of socio-clinical intervention (Monceau, 2003). They are organized for teams of in-service teachers (but also for other professionals in human relations professions—educators and trainers in particular) in their own field and thus fall within the scope of lifelong learning. These are long-term interventions: at least one year, often several years. The intervention is organized around 3 to 4 two-day sessions per year (after a few months or years, the sessions may only last one day).

The process may look like a practice analysis program. Each training session is based on three main phases: a phase of description of the situation that has been chosen by the group, a phase of analysis, and a projection phase in the action. The first, or even the first two or three sessions, are designed to allow the teachers to familiarize themselves with the methodological approach proposed and to grasp it. Therefore, during the first meetings, this method is implemented in a very formal way. Gradually, the degree of formalization decreases because the process and the principles underlying it are more mastered by the participants.

Among the three phases proposed in each session, the first is the narrative phase. In Dewey's words (1938, p. 109), it is intended to identify the constituents of the situation. It aims to produce as factual a description as possible, a narrative produced by one of the participants. In Dewey's sense, thinking begins when people acknowledge authentic doubt (p. 7), agree to abandon their convictions and consider that the situation is truly undetermined and that it still has to be defined. The challenge here is to "tell" the situation by refraining from mobilizing the categories that are very familiar to teachers. Each statement that would mobilize such a category is reformulated with the help of the facilitator. It is also about the speaker taking the time to identify parameters of the situation that the person generally does not know about—the parameters referring to the organizational and pedagogical dimensions of the situation. This narration is done at a very slow pace: if the sessions last two days, it is because the group can spend several hours, sometimes a full day, describing an event that lasted only one or two minutes. What is described is a situation, not a professional practice (professional practice is considered one of several parameters of the situation, and a very secondary one).

The second phase is dedicated to analysis. By analysis, we mean the identification of all potential determinants of the situation experienced—not the parameters that are considered to have *actually* played a role but the parameters that potentially *may* have. One does not seek to give one's opinion, to take a position, to produce interpretations: one plays with producing the longest possible list of factors that can come into play by looking far beyond individual factors. Participants are advised not to devote too much energy to researching these individual factors and to focus on situational dimensions, group dynamics, and pedagogical determinants. This phase is essential: it is at this point that the facilitator will propose to the participants new analytical frameworks that are often far from the participants' culture—perspectives from philosophy, particularly phenomenology and pragmaticism, anthropology, microsociology, linguistics, especially pragmatic linguistics, semiotics, rhetoric (Pesce, 2014b). It is in this phase that participants learn to put on new glasses. No formal input of more than a few minutes is made by the facilitator, who participates like everyone else in the analysis. However, participants are gradually developing a new conceptual toolbox, taking over a large number of resources that will in turn help them define the situations that they experience in a new way.

The third phase consists of projecting oneself into action: the group has made hypotheses (about the meaning of the situation) that are new for them, and wonder how they could act based on these hypotheses: if these assumptions are true, then here is what we are going to try to do. If the situation is not about a difficult child,

but about a child in difficulty, here are the effects we are going to work towards, and here are the concrete actions, the new organizations that we are going to experiment with to achieve this goal. At the end of the session, participants leave with a plan of action that they will test in the field. This plan contains a trace of (and makes it possible to actualize) the new categories of analysis, new theories, that the group is appropriating. During the next session, new situations experienced in the meantime can be analyzed, but above all, the group will recount and analyze the experiments carried out. If we find in this new session that the new tools implemented have started to show positive effects, it means that the theories we have mobilized since the previous session are valid. In the terms of Peircean pragmaticism, a concept is only true to the extent that it is true in its effects (Peirce, 1905/1998). Thus, little by little, new modes of reading show that they are more relevant than the old ones, which they replace. By constantly moving back and forth between analysis and experimentation, these new concepts, these new definitions of the situation, are incorporated by the participants. While they are first mobilized only in the analytical form according to system 2, that is, slow and reflective thinking, they gradually support the activity that mobilizes system 1, intuitive and rapid thinking.

CONCLUSION: FROM NAIVE MORALITY TO DELIBERATION-BASED ETHICS

When we describe these methods, we are frequently told that it is a form of practice analysis, a variant of other practice analysis methods. This is true if one only looks at the surface features of the program. This is not true if one considers the dynamics of the training, the processes that take place within it, and the type of transformations targeted. These specificities can be described at four levels.

The first level is that of duration: whereas a practice analysis lasts two or three hours, a session lasts fourteen hours in the early phases of intervention. This duration largely conditions the process, allowing an extraordinary deceleration of the rhythm of speech and thought. This duration makes it possible to free oneself from the usual categories of interpretation, which is not possible with traditional practice analysis methods.

The second level concerns the focus: here, we are not interested in practices but in situations. Insisting that the individual practice of the teacher is a minor parameter of the situation radically changes the way of thinking, the way of observing situations, perceiving them, interpreting them.

The third level is the one of the analytical frameworks involved. As soon as one mobilizes pragmatism, semiotics, phenomenology, anthropology, and no longer only psychology or sociology, completely new analyses are produced. Whereas traditional practice analyses transmit and confirm old analytical frameworks (those that do not work), these types of programs replace them with others. These new frameworks appear at two levels: analytical techniques and instructions that are configured by these new reference frameworks and the opportunity for the participants to develop theoretical learning about these analytical frameworks.

The fourth level is that of reflexivity. If participants describe, analyze and then act on a framework based on these disciplines and theoretical frameworks, they have the opportunity to reflect with the facilitator on the fact that they are doing so and to question why they are doing so. They are invited to engage permanently in a "meta" activity focusing on the program itself: what are we doing? In what way? How do we interact? With what words, what rules of interaction? What are the effects of this way of interacting, of the theoretical frameworks we mobilize? What is the difference from what we usually do? How, after the end of the intervention, can we continue to work together in this way?

Practitioners observe themselves working together and theorize not only about situations in the field but also about this specific way of thinking about situations in the field. They become aware of the new ways of speaking and thinking that are being implemented and can make them their own. They understand that they have moved from naive morality and psychology (which consists of attributing intentions to individuals and associating stable psychological dispositions with these persons) to an approach that is no longer moral but rooted in an ethic of collective work and based on precise deliberation procedures defined by rules, methods and techniques. In this way, they develop symbolic wisdom (Burke, 1955). They take control over how they collectively make decisions to resolve critical situations. They understand the mechanisms of systems 1 and 2, or the modes of functioning of the habits of belief, conduct and action. They gradually understand the challenges of moving back and forth between these two systems and collectively learn to control these passages voluntarily and actively. This ability to mobilize both system 1 and system 2 is all the more important since the use of system 2 does not guarantee the production of more rational judgments. Judgments produced according to an analytical approach are based on premises that may be wrong, and thus take the form of paralogisms (Leake, 1995; Evans, 2007, pp. 82sq). However, one of the main functions of the voluntary use of system 2 is to deconstruct these reasonings, their premises and logical articulations, in order to identify and transform the habits of interpretation on which the inferences produced by the professionals are based.

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Chapter 11
Why We Need a Construction Approach to Logic Education

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ABSTRACT

This chapter introduces a construction approach to logic education by explaining why such an approach is needed and how it should be implemented. The chapter is divided into two parts. The first part argues that conventional logic education cannot teach people how to make a practical use of logic because what people commonly learn from conventional textbooks of logic can hardly correspond to the ordinary way of reasoning. The second part highlights how the construction approach can be integrated into people's ordinary way of reasoning by being practical and constructive in helping people use logic in what they do, such as writing an academic paper. It presents a general framework about how a logical relation can be constructed from scratch, and the three major steps of the construction.

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INTRODUCTION

The primary focus of logic studies lies in an inferential relation linking two kinds of statements within an argument, which are technically called the premise and conclusion of the argument. For example, you are waiting inside a subway station and observe that almost everyone who comes into the station has a wet umbrella. The observation reliably leads you to infer that it is raining outside even though you cannot directly observe what is happening outside. Thanks to the inferential relationship, you can come to know that it is raining outside based on the observation of wet umbrellas.

In one sense, the observation about the umbrellas can be regarded as the premise, because it is what makes you infer that it is raining outside, which is the conclusion in this sense. But in another sense, what has been observed can also be regarded as a conclusion or consequence, and it can be used as a base to find out the cause of the umbrellas' being wet, which in this case is the rain falling outside. In either sense, the logical relation between premise and conclusion is the subject of the study of logic.

Since logic studies are essentially about the logical relation between premise and conclusion, an important task is to find out how the relation between the two statements can be constructed; i.e. how we could logically connect one statement with another from scratch? However, conventional studies of logic have been pursuing a slightly different path in the study of the logical relation. Although they are interested in how the premise and conclusion are related, they tend to look at the relation from the perspective of an "argument", a top-down perspective that covers the totality of premise and conclusion. From that perspective, their interest lies primarily in the principles or rules that make the relation valid; i.e. what are the principles of validity that govern the relation?

The two different perspectives on how the statements are logically related lead to two rather different directions. One focuses on the development of analytical tools and techniques that could help to distinguish between valid and invalid arguments, whereas the other focuses on the development of practical pedagogies that could help people learn how to construct a logical relation from scratch. It is our ultimate intention in this paper to show that an understanding about what makes a logical relation valid does not amount to an understanding of how to construct a logical relation. And the reason is basically due to a gap between logical assessment and logical construction.

Conventional studies of logic can be basically categorized into two different approaches, formal approaches and informal approaches. Briefly, the formal approaches study the inferential relation between premise and conclusion by

presenting the statements using some arbitrary symbols, whereas in the informal approaches premise and conclusion are presented using terms and sentences employed by natural languages. But despite the apparent differences in the way the premise and conclusion are presented, both formal and informal approaches share basically the same goal in the study of logic, which is nicely summarized by the definition of logic given by Irving Copi: "Logic is the study of the methods and principles used to distinguish correct from incorrect reasoning" (Copi and Cohen 2005, p. 4).

The definition of logic places the primary goal of the conventional approaches to the study of logic on the *assessment* of logical relations. Obviously, only through the assessment of logical relations, the rules and principles underlying the relations can be identified and used to distinguish between valid and invalid arguments.

Indeed, Aristotle's categorical syllogism, which represents the glorious accomplishment of classical logic, was basically an assessment study about what the proper structure of an argument should be. Gottlob Frege's quantification theory, which gave birth to modern mathematical logic, was specifically designed as an assessment tool for the study of the philosophy of mathematics. Even the informal approaches to logic studies, notably led by Howard Kahane, were to teach people what makes reasoning cogent by means of a critical study of what makes reasoning fallacious (Kahane, 1971).

However, although these assessment approaches to logic are very useful for understanding the structure of a valid argument, they are not very useful for helping one learn the way of constructing a logical relation from scratch. There is a gap between assessment and construction of a logical relation. In the cases of assessing a logical inference, statements from which the inference is drawn are usually provided. But in the cases of constructing a logical relation, the process would normally have to start from nothing. Furthermore, in order to distinguish between valid and invalid arguments, one may simply memorize the valid forms of argumentation. But such memorization does not help one to construct a logical relation from scratch.

Although it is our ultimate intention to draw a principled distinction between the assessment and construction approaches to the study of logic, the project is too huge to be fully covered in this short paper. What we are aiming to show in this paper is only the following: Conventional studies of logic are not very useful in teaching people how to construct a logical relation from scratch. As a result, we need a new approach – the construction approach – to do the job.

For this purpose, the paper will be divided into two parts. The first part is to explain why the conventional approaches are not useful for the teaching as well as learning of the construction of logical relations, and thus why a new approach is needed to do the task. The second is to highlight what the construction approach to logic is, and how it should be implemented.

Figure 1.

COMMON LOGICAL MISTAKES

Although the primary interest of the conventional study of logic lies in the principles of validity, it does not help to prevent the vast majority of people from making logical mistakes. This indisputable fact firmly shows that the conventional approaches are not effective in teaching people how to use logic properly.

Wason Selection Task

First of all, it has been demonstrated, through a well-known reasoning experiment called the Wason selection task (Wason, 1968; Wason & Johnson-Laird, 1972), that most people cannot even perform a very simple and straightforward inference task correctly.

Roughly speaking, one of the goals of the Wason selection task is to find out whether we reason in accord with the valid forms of deductive reasoning by testing whether we can make correct logical inferences based on a conditional rule of deductive inference. To do that, a subject is given four double–sided cards with information pertaining to a conditional rule, and the subject is asked to test whether the rule is true or false by selecting the appropriate cards to turn over. The four cards look more or less like the following:

And the conditional rule says something like this: "If a card has a vowel on one side, then it has an even number on the other side." For convenience, let's formalize the rule and the cards into the following:

Rule: *P* -> *Q* (i.e. *IF P THEN Q*)
Cards: *P*, *NOT-P*, *Q*, *NOT-Q*

The solution to the selection task is vivid and straightforward. Anyone who has a good knowledge in modus ponens and modus tollens should know that the correct cards that should be selected to test the rule are A (*P*) and 7 (*NOT-Q*). But despite the logical simplicity and vividness, more than 90% of participants choose to turn over A (*P*) and 4 (*Q*) (Wason 1977).

There are many theories about the massive failures in performing this reasoning test. But the conclusion of the Wason selection task is clear: People do not know how to reason in accord with the valid forms of deductive reasoning.

It might be argued that the reason why people failed the reasoning test is because they have not been taught the knowledge of deductive logic. Thus, if they had been taught, they would know how to make correct inferences. However, the following examples will show that this is not the case.

Failures Found in Students Who Took a Conventional Course in Logic

The failures in making logical inferences can be also found in people who have successfully completed a conventional course in logic, which covers the topic of deductive reasoning. Here we shall present a few real examples extracted from academic papers written by some graduate students of Nagoya University who specialize in Information Science. All the examples are directly translated from the students' writings in Japanese.

Example 1:

In earlier times, technology products were used to be simpler and less sophisticated, so people could easily take them apart and build them up again to know how they work. This resulted in the growth of interest and curiosity, which in turn brought forth a rapid economic growth in postwar Japan.

Example 2:

It is very important to reconsider what is humanness and why anti-technology movements came into the world. Because, unless we understand the reason why humans got scared of machines, even the most sophisticated robots would be rejected by their first impression.

Example 3:

In conclusion, the innovation of information technology is only extending our bodies and this suggests that Luddite anxiety about the future of technological society is groundless. However, Neo-Luddism is critical for preventing our society from lapsing into a techno-dystopia.

Example 4:

The outbreak of BSE revealed the lack of people's science literacy in Japan. And there emerged a vicious circle of consumers' wrong-headed behaviour and improper press coverage. That is why improvement of science literacy is the most effective means of securing food safety in Japan.

Example 5:

In the case of information technology in the late 20th century, humans and machines fused together and got well balanced. Therefore, the existence of neo-Luddism, in a sense, pave the way to the man-machine co-existence. Conversely, we could think that if we choose the way to the man-machine co-existence, the the raison d'etre of neo-Luddism will be undermined. In addition, seeing from another perspective,.....

Example 1 seems to argue for a causal inference between one thing and another. But none of them seems to be logically connected with another. There is no reason to believe that "people could easily take [technology products] apart and build them up again to know how they work". In addition, there is no connection between the given statement and the growth of interest and curiosity, let alone the connection between the growth of interest and the rapid economic growth.

In Example 2, the student uses "because" to connect the first and second sentence together. But the second sentence does not provide the reason for the first.

The connection mistake in Example 3 goes even further. The student is making a contradiction without any awareness. What is said in the second sentence clearly denies the first sentence.

In Example 4, the third sentence appears to be the "conclusion" of a pseudo-argument. However, we cannot understand why it follows from first two sentences.

In Example 5, the subject of discourse flows and drifts like free-association.

All these five examples of logical failures have one thing in common; namely the authors do not know how to logically connect one idea with another, even though they have successfully completed a conventional course in logic at a top ranked university.

REASONING HABITS IN EVERYDAY LIFE COMMUNICATIONS

Through the Wason selection task, we demonstrated that deductive logic is not compatible with how ordinary people reason. And through the writing examples we collected, we demonstrated that conventional logic education is not really useful in helping students construct logical arguments using their own ideas. The problem is fundamentally caused by a gap between how people reason in everyday life communications and what people learn from conventional textbooks of logic.

Roughly speaking, in everyday life communications such as having a conversation, writing a text message, etc., we have a habit of reasoning in a rather 'speedy' way. The communications are normally carried out with those people we know, such as friends, family members, colleagues, etc. Under these circumstances, we usually do not explain or express everything in the communications. When you clarify your definition about love to your wife, you usually do not make it as clear as when you define the terminology in a research paper. And when you explain to your best friend why she should spend more time with her family, you hardly need to make your explanation as logically convincing as when you make an academic argument. It is normal for you to skip a lot of details and jump to conclusions in those communications. For example, it is very normal to hear people saying things like "Peter cannot come to work today because his car broke down", or something like that in everyday life communications.

Obviously, the reason for Peter's absence from work is hardly convincing under logical scrutiny. It bypasses some important background information that logically connects the conclusion to the reason. If it were presented to those who do not share the background information about Peter and his everyday life, then many obvious questions would be invited.

Although the reasoning seems problematic, it is actually very normal for us to be speedy. Everyday life communications are usually conducted *collectively and interactively* with people who we know, or people who share certain background information with us. Since certain background information is shared in such communications, we do not have to waste time and energy to spell out all the details when we communicate our thoughts. We can make assumptions and expect the receiver to fill out the missing part with the background information shared. This is why the explanation for Peter's absence from work would normally be acceptable among those who share the background information with him. This is why people do not have to make so much effort in making their thoughts clear and convincing in everyday life communications.

However, the speedy way of reasoning becomes a problem when we communicate our thoughts to those who do not know us, or those who do not share the background information connected with the thoughts we intend to communicate. For example, writing a research paper for publication is a case of non-collective and non-interactive communication. In this case, we cannot assume as much about what the readers should already know. And we certainly cannot expect them to help making the thoughts clear and convincing.

In order to make the thoughts clear and convincing in writing an academic paper, one would have to depart from the habit of speedy reasoning. But this cannot be accomplished through the conventional approaches to logic education.

INADEQUACIES OF THE FORMAL AND INFORMAL APPROACHES TO LOGIC EDUCATION

We have just highlighted how people reason in everyday life communications. But what people learn from conventional textbooks of logic can hardly correspond to the everyday way of reasoning. Consider formal logic first.

Formal Logic

Formal approaches to logic cover both classical Aristotelian logic and modern mathematical logic. They are called "formal" because their primary study focus is the syntactic relations between the premises and conclusions, regardless of what the statements are *about*.

Gottlob Frege (1956), who was widely regarded as the father of modern mathematical logic, exclusively assigned logic the task of discerning the *laws* of truth: "All sciences have truth as their goal; but logic is … concerned with it in a quite different way ... To discover truths is the task of all sciences; it falls to logic to discern the laws of truth".

Since it is the laws of truth rather than truth per se that logic is tasked with discovering, the primary focus of logic study lies in the analysis of the validity of the syntactic relation between one statement and another to discern the general principles governing the relation. For this purpose, a statement in the formal studies of logic is commonly abbreviated using some arbitrary symbols in order to highlight the syntactic relation that it bears to other statements rather than the external relation that it bears to the things in the extralinguistic world.

The reason for abbreviation using arbitrary symbols is clarity. Words and sentences employed by natural languages are primarily used to convey meanings. They are heavily contaminated with lexical and structural ambiguities, and thus they are not the ideal candidates for a serious study concerning the laws of truth. In order to remove the unwanted ambiguities to derive a clearer understanding about the laws, a set of arbitrary symbols are used instead.

The focus on the laws of truth and the use of arbitrary symbols, however, places the study of logic at a level that is highly detached from the ordinary way of reasoning. The purpose of formal studies is not to foster a practical understanding about how one can reason in a convincing way, but to discern the principles and laws governing the logical relations among statements in general. The symbols and their relations used in formal logic are not supposed to represent how things are actually related in the extralinguistic world. They are primarily used for the purpose of assessing the validity of logical relations. As a result, it is very difficult for people to apply logic studies to their everyday reasoning where particular and actual events matter.

Worse still, the knowledge of formal logic is to a large extent not transferrable into ordinary reasoning. In fact, sometimes the former even interferes with the latter. Consider the following example.

Suppose a kidnapper sent you a blackmail note including the following sentence:

(1) Unless you pay $1,000,000 in ransom, we will kill the hostage.

And suppose that you paid the ransom but found the hostage was killed by the abductor anyway. Naturally you will be outraged by what the abductor did and cry "you lied, you bastard!". But unfortunately, in a formal logic course, your reaction would be regarded as illogical!

Formal logic translates (1) into something like (2).

(2) not P -> Q

And the case where you paid the money and the hostage was killed will be formalized as the following:

(3) P & Q

The rules of formal logic tell us that (2) does not contradict (3), because the negation of (2) is not (3) but (4).

(4) not P & not Q

This example shows us in ordinary reasoning "unless" (and sometime "if" as well) is interpreted as biconditional. You took (1) not as (2) but as (5).

(5) not P <-> Q

So interpreted, (3) falsifies (5), i.e. (1).

The important thing to note is that there are no formal rules to tell us whether we should formalize (1) into (2) or (3). It is totally dependent on the context and the content.

Informal Logic

Knowing that formal logic is too abstract for ordinary reasoning, an informal approach to logic studies has been introduced since the early 1970s to focus on "The Use of Reason in Everyday Life" (Howard Kahane, 1971). Other famous proponents of the informal approach to logic include M. Scriven (1976), Fogelin, R. J. (1978), etc. Under the informal approach, students do not have to study logical relations by focusing on the formal relations of arbitrary symbols. Instead, they learn what constitutes good reasoning from real life examples of fallacious reasoning found in TV broadcasts, newspaper articles, advertisements, and the rhetorical speeches made by politicians and other public figures.

In addition to being informal, Kahane's approach was also intended to be practical. His goal was to teach people how to reason well in everyday life, or "what makes reasoning cogent". For this purpose, his textbook was designed as a practical instrument to help students learn to get access to the truthfulness of everyday life reasoning by analyzing what makes reasoning fallacious. Most parts of his book were organized around a discussion of fallacies, and most of the exercises in the book were designed to train students to identify the deceptions of deceitful rhetoric.

Without any doubt, informal logic does provide a clear alternative to people who want to study logic in a less formal and arbitrary way. However, both formal and informal approaches to logic are essentially the same concerning the focus of their studies. Both of them focus on the assessment of the logical relation between premise and conclusion in order to discern the laws or principles governing the relation. And for this reason, informal logic has the same problem as formal logic

concerning the application of logic to people's reasoning in everyday life. To be clear, the problem about logic education is not really about whether the study of logic is being conducted formally or informally. It is about how people can appropriately integrate the use of logic in their life so that their reasoning habit is not speedy under all circumstances.

Learning how to assess logical relations is of course very important. But there is no reason to suppose that by learning how to distinguish between good and bad arguments then people will automatically know how to build good arguments. Indeed, there is no reason to even suppose that they know how to build an argument at all. Knowing how to build a logical argument requires one to know how to build an argument from scratch. And one cannot learn that by merely knowing how to assess logical relations. The gap between logical analysis and logical construction is the real reason why people keep making logical mistakes even when they have completed a logic course.

CONSTRUCTION LOGIC

In the previous sections, we have argued that conventional approaches to logic studies cannot teach people how to use logic properly because of a gap between logic assessment and logic construction. In order to solve the problem, we need a new approach to teaching logic that can bridge the gap between logic and everyday life reasoning. Let us now introduce what we call the construction approach to teaching logic, or Construction Logic.

Construction Logic and Academic Writing Education

There are two main objectives of construction logic. The first one is to make logic education practical. Making logic education practical means making it applicable to what people do in their everyday life. It means that people can actually use logic for what they do, and make their life better with it. There are several ways to make logic education practical. But currently we are focusing exclusively on the exploration of one particular area, namely academic writing education. We believe that academic writing education is an ideal platform for making logic education practical.

To begin with, there is a practical need for every university student to learn how to write academic papers. All university students in Japan and elsewhere, regardless of whether they are postgraduates or undergraduates, are required to write academic papers in one form or another. At the very least, he or she will have to complete a dissertation or thesis in order to graduate.

As far as dissertations or theses are concerned, they are research writings that are argumentative in character. Most of the dissertations or theses are written to report some novel research findings, through presenting a convincing argument to support their originality. Regardless of whether they are written for the disciplines of the sciences or humanities, whether they are based on a study to understand an unprecedented phenomenon, or investigations to shed new lights on an old theory, research writings like dissertations are essentially written based on some novel ideas.

Because of the novelty, in order for the research findings to be accepted by the readers or listeners, the steps that led to the findings must be logically convincing. In other words, there must be a logical argumentation process to demonstrate how the research findings were reached. And in the argumentation process, the research writers must know how their ideas can be logically organized to maximize their convincing power.

The Construction Approach to Building a Logical Argument

The second objective of construction logic is to make logic education constructive. Making logic education constructive means providing step-by-step guidance on how to build a logical argument from scratch. Since the launch of the project of applying logic education to academic writing, we have developed a series of recipes that help our students build logical arguments based on their research ideas. The recipes are divided into two categories: (1) how to develop a thesis statement from scratch, and (2) how to develop convincing support for the thesis statement. Students learn how to build a logical argument by starting from a thesis statement, and then proceed to building the premises that provide convincing support for the thesis statement. In virtue of building a logical argument, construction logic aims to show how a thesis statement can be proven through premises that are capable of showing that the thesis statement is actually true.

Beginning with a Thesis Statement

The thesis statement is a natural place to start writing development as well as the argumentation process. It represents the main claim of an argumentative paper, or what the paper argues for basically. Being the main claim of an argumentative paper, the thesis statement is the basis from which an argumentative paper is developed. The relation between a thesis statement and other components of the paper can be seen as a logical relation, and it is in virtue of the logical relation that a thesis statement

is integrated into the paper. In this sense, the components of an argumentative paper are put together like a logical argument. Whereas a thesis statement functions as a conclusion to the argument, the rest of the paper functions as the premises that support the conclusion. Accordingly, writing an argumentative paper is essentially a process of developing the paper's thesis statement. In the beginning of the process, the thesis statement can be seen as a hypothesis waiting to be confirmed. The rest of the process is to collect the evidence to build the convincing support that aims to confirm the hypothesis. Once some convincing support for the hypothesis is properly established, then the thesis statement turns into a confirmed conclusion from a hypothesis.

Starting from a thesis statement allows students to start thinking and writing their papers from scratch. A thesis statement can be developed from a keyword, intuition, etc. However, a thesis statement is developed, students in our class are asked to present it in the form of one simple sentence. And the sentence needs to have the following components: (i) a subject, (ii) an object, (iii) a relation that links the subject to the object, (iv) a condition under which the relation between the subject and object holds true. Having built a thesis statement in this way, students gain a fairly clear idea about what their research claim is, and how to proceed to support it.

The thesis statement built at the beginning is only a preliminary one. It will be subject to modification again and again during the entire writing development. The subsequent stages of the writing development are to build the premises that can develop the thesis statement into a confirmed conclusion. As a result, the process of the thesis statement development cannot be fully completed until the entire process of writing the paper is completed, for the statement may have to be modified whenever some new information is discovered in the writing process. The thesis statement in the process of writing an academic paper and building a logical argument is the first to start but also the last to finish.

Starting with the thesis statement has several major advantages. One clear advantage is a sense of achievement for the students. Since a thesis statement is normally written in only one simple sentence, having it built at the beginning of the writing can make students feel that they are setting off in a clear direction.

The most important advantage for beginning with a thesis statement is an effective way of logical construction. In conventional studies of logic, for the purpose of distinguishing between valid arguments and invalid ones, the premise is notably the starting point of making an inference. But if one is to build a logical inference in an open setting, then starting from a premise would lead to an infinite regress. For example, the premise that "Peter is currently living in Nagoya" can infer that

"Peter is currently living in Japan". But it can also infer that "Peter is not living in England", "Peter is alive", "Peter needs oxygen to survive", and so on and so forth. There can hardly be a non-arbitrary stopping point in the inference process that begins with a premise. An inference starting from a premise could only be used for assessment studies of logic, in which some arguments or inferential relations are already given. It is not suitable for building an argument from scratch.

Building an inference based on a hypothetical conclusion (i.e. thesis statement) allows the process to be confined within a clearly defined boundary. To understand this, consider how a typical crime investigation is conducted. Very briefly and roughly, in a typical crime investigation, the investigation will begin at the point that a crime has been committed – e.g. someone has been murdered, or some bank has been robbed. A careful investigation of the crime scene is very crucial, and it determines the rest of the investigation. The injuries found on the body indicate the weapon used to cause the injuries, the hair or fingerprint found at the crime scene can help to identify the person who may be responsible, etc.

In the same vein, building a logical inference based on a hypothetical conclusion enables one to know what needs to be proven, and thus what needs to be done to deliver the proof. A careful study of the essential components of the hypothesis provides good guidance about the premises that are needed to support it. This point can be clearly understood through the "three-term" logic that forms the basis of Aristotle's categorical syllogism.

Although classical Aristotelian logic does not teach how to build a logical argument from scratch, its categorical syllogism does provide good hints on how premises can be developed based on a conclusion. A categorical syllogism is a deductive argument containing three statements. The first two statements are technically called the major premise and the minor premise respectively, while the third statement is called the conclusion. The three statements are built based on three syllogistic terms: the major term, which serves to form the major premise, the minor term, which serves to form the minor premise, and the middle term, which serves to connect the major premise and the minor premise.

As a validity rule, both the major term and the minor term must reappear in the argument's conclusion; the former serves as the conclusion's predicate whereas the latter serves as the conclusion's subject. Since the major term and the minor term are the building blocks of the major premise and the minor premise, and since the major term and minor term also serve as the conclusion's predicate and subject respectively, we can get a basic idea about what the premises should be like by looking at the conclusion alone.

Practical Application of a Correspondence Theory of Truth

Although the idea of starting from a conclusion in building an argument seems radical, it does have a well-respected philosophical foundation. Construction logic is heavily influenced by a correspondence theory of truth, the historical origin of which can be traced back to the logical atomism advocated by Wittgenstein (1922) and Russell (1918). The theory basically claims that "*S*" is true if and only if "*S*" corresponds to some fact or state of affairs that obtains. This claim is used in construction logic as a guidance on how a thesis statement should be proven. Note that the term "*S*" here does not stand for a whole statement. It is one of the atomistic components that functions as a truth-bearer in the statement. A statement as a whole is the combinatorial product of atomistic components. The fact or state of affairs to which the truth-bearer corresponds is a truth-maker that is some portion of extralinguistic reality. Construction logic is influenced by the theory of truth because its primary objective is, in virtue of building a logical argument, to show how the truth of an argument's conclusion can be ultimately proven by reference to the corresponding facts or states of affairs in the extralinguistic world.

Although construction reasoning is based on a philosophical theory, it is not designed as a philosophical development of the theory of truth in order to better clarify the terminologies used in the theory or tackle the problems the theory faces. Rather, it is designed as a practical application of the theory of truth for educational purposes. Through the practical application of the theory of truth, construction logic aims to teach students how to build a convincing argument for their research papers by teaching them how to build the premises that are capable of proving that the main research claim made in a research paper is *actually* true. In doing so, the terminologies used in the theory, such as "truth", "facts", "states of affairs" are largely simplified and idealized to allow students to develop practical knowledge about things that can be counted as evidence to support an argument.

Since construction logic aims to teach students how to build a convincing argument by reference to facts or states of affairs in the extralinguistic world, construction logic differs from conventional studies of logic in another major aspect. As we covered earlier, conventional studies of logic focus on the assessment of arguments by reference to principles of validity. The primary focus of such studies lies in analyzing the internal relations among the statements within an argument. And in doing so, the studies would not care about the external relations that the statements bear to some specific parts of reality. For assessment studies, it is not primarily important whether the statements of an argument are *actually* true or not. The truth or falsity

of a statement in assessment studies is assumed, not assured. Unlike conventional studies of logic, construction logic does not make any assumption about the truth or falsity of a statement. Construction logic basically claims that the statements of an argument are true *ultimately* because there are states of affairs in the extralinguistic world that can prove that the statements are true. Accordingly, whether a statement is true or not ultimately depends on whether the states of affairs to which the statement corresponds actually obtain or not in the extralinguistic world. The external relation that the statements of an argument bear to the states of affairs in the extralinguistic world is the primary focus of construction logic.

Building Premises Based on a Conclusion

Having started with a thesis statement in the argument construction process, the next step is to build the convincing support for the statement. The convincing support is composed of the premises that are capable of showing that the conclusion is actually true by reference to some specific facts or states of affairs in the extralinguistic world. Inspired by the correspondence theory of truth – i.e. "*S*" is true *if and only if* "*S*" corresponds to some fact or state of affairs that obtains, in order for a conclusion to be fully convincing, it must be supported by two kinds of premises. One kind of premise functions to provide the sufficient condition for the statement to be true, whereas the other functions to provide the necessary condition. In construction logic, the premise that provides the sufficient support is called the Premise Of Proof (POP); the premise that provides the necessary support is called the Premise Of Defense (POD).

Premise of Proof (POP)

POP is the first type of premise to be established in the process of constructing the convincing support for a thesis statement. Building POP is just collecting and presenting the evidence that can prove the thesis statement. If the evidence collected is sufficient, then the truth of POP infers the truth of the conclusion; in other words, if POP is true, then the conclusion is true.

In the construction of POP, the term "evidence" is used instead of "fact" or "state of affairs" for a practical reason. Consider the statement, "there is a pig in the farm". In order for the statement to be true, there must be actually the case that *there is a pig in the farm*. However, things in reality usually do not happen in such an ideal way. Instead of finding a pig in the farm directly, one might only be able

to find some footprints and pig bristles in the farm that indicate the presence of a pig in the area. The footprints and bristles are not the pig per se but nevertheless are reliable indicators of the presence of a pig. The reliable indicators of a pig are evidence of a pig. Since construction logic teaches how the truth of a statement can be proven practically, the use of "evidence" is perhaps more realistic than "facts" or "states of affairs" for practical investigations.

The most crucial part of building POP is identifying the evidence (***E***) for a thesis statement (***TS***). There are three conditions that must be fulfilled in order for something to be counted as ***E*** for ***TS***. First, ***E*** should be composed of things or activities that actually exist in reality, and as a result, ***E*** is verifiable from a third person point of view. Second, ***E*** should bear an inferential relation to ***TS*** so that if ***E*** is proved to be true, then ***TS*** would be true or probably true by inference. Third, the inferential relationship between ***E*** and ***TS*** must be content-relevant in the sense that ***E*** must be relevant to the content of ***TS***.

The first condition reveals a categorical difference between ***E*** and ***TS***. Whereas ***TS*** refers to an idea being represented in some linguistic form, ***E*** refers to the actual things or activities found in the extralinguistic world.

The second condition serves as a general guideline for how to identify ***E*** for ***TS***. Whatever ***E*** is, it should bear a special inferential relation to ***TS*** in the sense that if ***E*** is true, then ***TS*** is true or probably true. This guideline here is largely simplified and idealized for illustration purposes. A more specific and realistic version used in construction logic is Bayesian conditional probability. That is, something is ***E*** for ***TS*** if and only if the probability for ***TS*** to be true given ***E*** is greater than the probability for ***TS*** to be true without ***E***. Similarly, something is not ***E*** for ***TS*** if and only if the probability for ***TS*** to be true given ***E*** is less than the probability for ***TS*** to be true without ***E***.

The third condition specifies an additional requirement for the inferential relationship between ***E*** and ***TS***. That is, in order for ***E*** to infer ***TS***, ***E*** must be relevant to the content of ***TS***. The requirement here is about content relevance. And it radically differs from the conventional understanding about logical inference, which is limited to the formal properties of the statements within an argument, regardless of the contents of the statements. The content relevance requirement suggests a 'matching process' that matches ***TS*** with the things or activities through which the idea could be actually realized – hence confirmed – in reality. The 'matching process' here can be viewed as a practical process of 'correspondence' between a statement and facts or states of affairs in the extralinguistic world.

Since ***E*** must be relevant to ***TS***, ***TS*** is the basis for finding ***E***. The content of ***TS*** serves as the basic guideline for understanding what counts as the evidence and even how it can be collected. Accordingly, there are at least two major categories of things

or activities that can be counted as evidence. First is the direct instantiation of the component of a thesis statement. The direct instantiation of an idea is the specific object or activity in the real world through which the idea is instantiated. For example, a direct instantiation of "Peter" is the person in the real world named Peter. A direct instantiation of "teach" is the activity in the real world that is generally regarded as teaching. Strictly speaking, direct instantiation is not evidence per se. The person named Peter does not indicate Peter; he is Peter. However, direct instantiations of atomistic terms can be used as evidence to prove a statement, such as "Peter teaches logic at the university". Second is the reliable indicator. A reliable indicator is the most common sort of evidence that we are looking for. For example, fingerprints of Peter reliably indicate Peter. Under the normal circumstances, the presence of Peter's fingerprints reliably indicates the presence of Peter.

Premise of Defense (POD)

Knowing the evidence that is needed to prove a conclusion does not mean that one can actually get that kind of evidence. In fact, it is almost impossible to find the evidence that can provide the absolute proof. Thus, whether or not the support for a conclusion is convincing does not only depend on having the evidence that can prove the conclusion. It also depends on whether or not the known possibility or possibilities for the conclusion to be false can be eliminated. Even if the evidence collected is not ideal for proving a conclusion, as long as it can be shown that the conclusion is not false, then there is the convincing support nevertheless.

The unlikelihood of finding the evidence that provides absolute proof creates the need for having the second type of premise in building the convincing support. This premise is called the Premise of Defense, or POD. POD specifies the necessary (but not sufficient) condition for a conclusion to be true in the sense that if POD is false, then the conclusion is false.

As shown above, the content of a conclusion serves as the basis for identifying the evidence that makes it true. But it also reveals the major possibilities for the conclusion to be false. For example, if there is no evidence that can provide the absolute proof for the claim, "greenhouse gas emitted by humans has been causing global warming since the industrial revolution", then it is possible for the claim to be false. That is, it is possible that global warming is not caused by the greenhouse gas emitted by humans. Such a possibility is clearly revealed in the contingent relationship between the greenhouse gas and global warming. Accordingly, in order to defend the claim, the possibility for it to be false would have to be eliminated. If the defense fails, then the claim fails to be true.

Knowing how to make logical inference by eliminating a possibility is a very important skill for reasoning. Detectives use this skill to narrow down the search for criminals by eliminating suspects one by one. Lawyers use this skill to prove the innocence of their clients by eliminating the possibilities of guilt one by one. Indeed, this skill is crucial to solving almost all the logical puzzles. Consider the following puzzle used in Copi and Cohen's book (Copi and Cohen 2005, p. 60-61).

Alonzo, Kurt, Rudolf, and Willard are four creative artists of great talent. One is a dancer, one is a painter, one is a singer, and one is a writer, though not necessarily in that order.

Hints:

(1) Alonzo and Rudolf were in the audience the night the singer made his debut on the concert stage.

(2) Both Kurt and the writer have had their portraits painted from life by the painter.

(3) The writer, whose biography of Willard was a best-seller, is planning to write a biography of Alonzo.

(4) Alonzo has never heard of Rudolf.

What is each man's artistic field?

As we can see from the puzzle, no direct information is given about what each man's talent is. We can only infer it by finding out what each man is not. Accordingly, there are basically two major steps to solve this puzzle. First is to list all the possibilities covering the four people and four talents using a "matrix" (a table of rows and columns). Second is to draw inferences by eliminating the possibilities given in the hints one by one. For example, according to hint (2) – *Both Kurt and the writer have had their portraits painted from life by the painter* – we know that it is not possible for Kurt to be the writer (and the painter). And according to hint (3) – *The writer, whose biography of Willard was a best-seller, is planning to write a biography of Alonzo* – we know that it is not possible for Willard and Alonzo to be the writer as well. Since it is not possible for Kurt, Willard, Alonzo to be the writer, we can reliably infer that Rudolf is the writer. This is how inference can be made through eliminating the possibilities.

Similarly, the skill can be used to defend (make inferences about) the truth of a claim by eliminating the possibility or possibilities for the claim to be false.

CONCLUSION

This chapter is divided into two parts. The first part explains why there is a need for a new approach to teaching logic studies called construction logic. The second part explains how construction logic can be actually implemented to help students learn to construct a logical relation from scratch. In particular, a practical platform of implementing construction logic is academic writing education. The three major steps of building a logical argument are: (i) building a thesis statement, (ii) building a Premise of Proof, (iii) building a Premise of Defense. But due to the limited space in this chapter, we cannot present the detailed recipes that demonstrate exactly how the steps are accomplished. And for the same reason, our argument against the conventional approaches to logic studies could only touch the surface of a much bigger project that aims to draw a principled distinction between the two approaches. Our purpose in this paper is merely to introduce the possibility of a new alternative in the teaching of logic. We believe that, once this possibility is acknowledged, the door to an uncharted territory in higher education is opened for logic and philosophy.

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Chapter 12
Humanizing the Intellectual Capital to Optimize Knowledge Management Systems in Organizations

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ABSTRACT

This chapter identifies the best way to measure, develop, and manage intellectual capital as part of knowledge management. The Ministry of Education is a federal organization whose environment has been studied in all aspects of intellectual capital to identify its model, methods, and tools for measuring, developing, and managing intellectual capital. The qualitative method was used to collect results, encompassing interviews, document reviews, direct observations, and focus groups. It was concluded that there is genuine interest within the ministry to develop its intellectual capital and invest in its different dimensions. The chapter offered several contributions, the most important being the process for measuring, developing, and managing of intellectual capital. It also recommends a sustainable and continuous professional development process for employees. Institutions must also pay attention to the knowledge, skills, and innovations derived from the human mind and harness all the supporting potential, which in turn helps develop institutional administrative work.

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INTRODUCTION

The world today is witnessing many rapid changes in human life, including intellectual, social, economic, financial and political transformations. More importantly, there is globalization's influence on the human element. All these transformations have been linked to several factors, including organizational, financial and technical, which have had a significant impact on working life. Globalization, the enormous number of technological innovations, big data, and all the transformations in the world around us have imposed on organizations the need to thrive in a highly competitive environment to raise their value and achieve their desired strategy.

There has been a tremendous knowledge explosion, and knowledge management has become necessary to organize this knowledge. Knowledge management is a science that emerged as a result of the importance of knowledge in the information age and the need to face the data resulting from life in the present era, which is represented by the tremendous technological development and the density of information produced in all fields and the speed of access to it. This development has created the need to organize and manage it. Each organization must seek maximum benefit from its quantity of knowledge and how to maintain and guide it to ensure the achievement of its strategic objective (Goel, 2010). Knowledge management is not only intended to manage tangible knowledge assets such as databases, documents, policies, and procedures, but also to manage the knowledge, expertise, and skills of individuals and groups (Singh & Soltani, 2010).

Organizations must prove their capacity and position by keeping up with modern developments, looking to the future with insight through the adoption of non-traditional management methods for knowledge, making maximum use of their intellectual assets and attracting human resources that add value to the knowledge of the organization (Singh Sandhawalia, 2011). The attention to intellectual assets, which include the experience, knowledge and skills of an individual, is much greater than interest in physical assets, which include cash flows and profits. Accelerated transformation towards a knowledge economy and knowledge society strongly imposes on intellectual capital—how it is managed, measured and developed (Bismuth, 2008) . Therefore, many strategic and executive leaders have paid much attention to human resources that must be directed to those who have the knowledge, experience, creative capacity, development, investment and preservation that are the firm intellectual assets of the organization (Cheng, 2017) .

Organizations with leading minds in the field become highly competitive with other organizations. In many organizations, there is an untapped intellectual potential. All organizations must learn how to use and manage these assets to reach their

maximum cognitive and intellectual potential by managing intellectual capital more effectively to reach organizational excellence based on knowledge (Lerro, 2014). Organizations realize that intangible assets, such as intellectual capital, are the key to improvement, development, and competition. Therefore, interest in this element must be developed, measured, and managed to properly generate knowledge.

BACKGROUND OF THE STUDY

The great challenges and rapid transformations in the world around us today have affected small and large organizations, so that few organizations are now working without a clear, defined vision that will orient them for the future and prepare them for all challenges. The recent crises, whether financial or political, have overthrown many organizations that have not been able to withstand these challenges. This has led to the search for a successful strategic tool that enables such organizations to avoid such threats while enhancing their competitiveness (Leonhardt, 2014).

Knowledge today is the real resource for organizations and a strategic tool to adapt to the requirements of the present age. It is considered the main source of creating wealth and achieving excellence, creativity, and innovation. The role of knowledge, which is based on intangible and immaterial assets, has increased in the course of enormous development, leading to the emergence of the concept of intellectual capital, which was characterized as difficult to measure, evaluate, and manage (Nahapiet & Ghoshal, 1998). This is true because it is difficult to measure the impact of intellectual capital in creating value for the organization. The focus of organizations have been more towards the emergence of interest in intangible assets such as patents, trademarks, and intellectual property. As mentioned previously, because of the tremendous technological development, the information revolution, and the increasing role of knowledge, the consideration of individuals as the makers and partners in this knowledge led them to begin to pay attention to intellectual capital (Leonhardt, 2014).

There have been many studies that emphasize the need to pay attention to intellectual capital and management. According to a theoretical study by a group of researchers (Bisogno, 2018), there is a rareness of scientific research that focuses on the management of intellectual capital in the educational field. Recommendations at the end of the paper suggested the need to expand the scope of research in the field of intellectual capital management so as not to lose its importance. The concept of intellectual capital remained unexplored until the so-called knowledge economy

emerged in the 1980s. In several attempts to search for new values in the knowledge economy to raise the performance of the organization and to achieve its competitive advantage, intellectual capital has been re-emphasized, as has its importance as a resource within the organization that helps achieve better results using the tangible core resources of the organization. In 1980, Hiroyuki Itami published *Invisible Assets*, a book that reviewed "the impact of invisible assets on the management of Japanese companies " (Roehl & Itami, 1987). This book did not become popular, however, until it was translated into English in 1987, when interest was first piqued in the concept of intellectual capital, and many researchers began to clarify its importance in raising organizational performance.

As revealed through many studies, both theoretical and applied, intellectual capital can be seen as know-how about how to generate and obtain information, organizational knowledge and how to create it, ability to apply skills, knowledge gained through training and experience and knowledge gained through mutual relationships. Intellectual capital is of great importance, as it contains strong intangible assets for maintaining a high level of knowledge within the organization. Additionally, intellectual capital is one of the most valuable sources in the age of the knowledge economy because it represents a scientific force capable of introducing successive innovations, expertise, and knowledge of the work of the organization. Harnessing intellectual capital is a strategic method to which many organizations have begun to pay attention, given the importance of IC in raising the organization's value and ensuring its sustainability and competitiveness (Choo & Salleh, 2010).

There is a link between intellectual capital and knowledge management practices to raise an organization's performance competitive value. Strong organizations that practice knowledge management are superior to organizations that have intellectual capital but do not practice knowledge management. A study by Husinki, Ritala, Vanhala and Kianto (2017) on the relationship between configurations of specific element of intellectual capital and knowledge management practices pointed out that future studies should build an accurate assessment model to assist the intellectual capital configurations of its elements and knowledge management practices to create a competitive advantage for the organization. This suggests for us as researchers that the fundamental elements of intellectual capital need to be studied, as well as how they are evaluated and how they relate to knowledge management practices. This study aims to identify the best way to measure, develop, and manage intellectual capital as part of knowledge management. The Ministry of Education in the UAE is a federal organization whose environment has been studied in all aspects of intellectual capital to identify its model, methods, and tools for measuring, developing, and managing intellectual capital.

Case Study: Ministry of Education

The Ministry of Education (MOE) is a federal government agency, which aims to achieve the government's strategic plans. MOE makes its own knowledge-based decisions. It has employed different methods and technological systems that have proven to improve the quality of work and, consequently, improved the quality of learning in the country. The main reason why the Ministry of Education is chosen as a case study for this research is the availability of a considerable number of systems, tools and methods used to manage its knowledge capacity.

Ministry of Education has several strategic indicators based on the UAE's 2021 Vision that aims to "provide a first-rate education system" (UAE Vision, 2018). This includes the transformation of the current education system and teaching methods. Curriculum development is needed in order to achieve high quality knowledge society, as well as providing a safe and supportive school environment. There is also the knowledge and data built for improving the efficiency of the leadership and educational bodies. This data ensures the quality of educational performance and dissemination of good learning for all. To achieve the desired strategy, the qualified staff should be prepared. So, it is important to closely explore MOE as a knowledge-producing institution and how it measures, develops and manages its intellectual capital. Furthermore, MOE contains a special training institute for training human resources, which is the first of its kind compared to other federal agencies. The research will also delve into the knowledge they have to achieve their strategic goals.

There are many intelligent technological systems in MOE, such as Performance Management System, Student Information System (SIS), Assessment analysis System, and Learning Management System (LMS). These systems at the Ministry of Education are at different stages, some fully operational while others are still under development and construction. Based on data generated by these systems, Ministry of Education can provide decision-makers in the country with the much-needed data for them to make data-driven decision to ensure quality education programs.

One of the most important reasons that made us choose the Ministry of Education as a case study for this research is the inclusion of the Learning Data Center. This center is the first of its kind in all federal government agencies. The Learning Data Center contains information for all staff members, teachers and students. These data are processed according to artificial intelligence systems to obtain information through which to make appropriate decisions. Learning Data Center systems are currently analyzing all data for school operations from teachers and students. It also regulates school bus traffic, constantly tracking weather conditions. There is a constant update on these systems. Having identified all the information about the Learning Data Center, it is possible for us to propose a model which can manage intellectual capital as part of knowledge management system.

METHODOLOGY

The main research questions that will be answered in this research are: 1) how intellectual capital can be measured in the organization; 2) how to develop intellectual capital in the organization; and 3) how to manage intellectual capital in organization.

The qualitative method was used in this research to answer the above questions. It relied on interviews, focus groups and document reviews to collect and analyze data. This had increased the understanding of the concept of intellectual capital and its importance, and had rectified some of the knowledge that was not very clear. Individual interviews were designed to deepen the understanding of the opinions, experiences and attitudes of others towards the subject of human capital and its role in raising organizational performance. This type of interview useful in identifying the person's point of view about the organization's training and capabilities to help them develop their skills and experiences more accurately and reliably are the measurement methods used to measure the level of intellectual capital he sees in his view convincing and measured accurately and correctly or not.

The individual interviews included directors and employees from different departments, and the same questions were also given to everyone, including those in the two focus-group interviews. Some of the individual interviews with directors included different questions, but the subjects remained the same so that the directors could confirm what the employees have said. Existing documents were also reviewed to identify the type of systems used to measure, develop and manage intellectual capital as part of the organization's knowledge management initiatives. For example, curriculum department documents, documentation for the training of personnel from the department of training and professional development, documents and statistics for events and activities designed to motivate employees and develop their skills and others. The study and analysis of documents lead to important results documented and very useful in research.

Data analysis came during and after data collection. Data and information such as written and audio interviews, various documents related to the subject matter, etc. was obtained. The technique used data analysis was Interpretive analysis. This phase involves ordering and splitting data into themes so that the most can be used as follows: transcribing, organizing, coding, writing, formulating and verifying. Several applications were used to facilitate the data analysis. "Voice memos" application was used to record the sound after approval from the participant. The interviews were then translated from Arabic to English, with more than half of the interviews being conducted in Arabic. Interviews in English have been used "Interviewscribelite" application to translate the phonetic expressions into text, but it was not that quality as we resorted to writing some texts afterwards.

Conceptual Framework

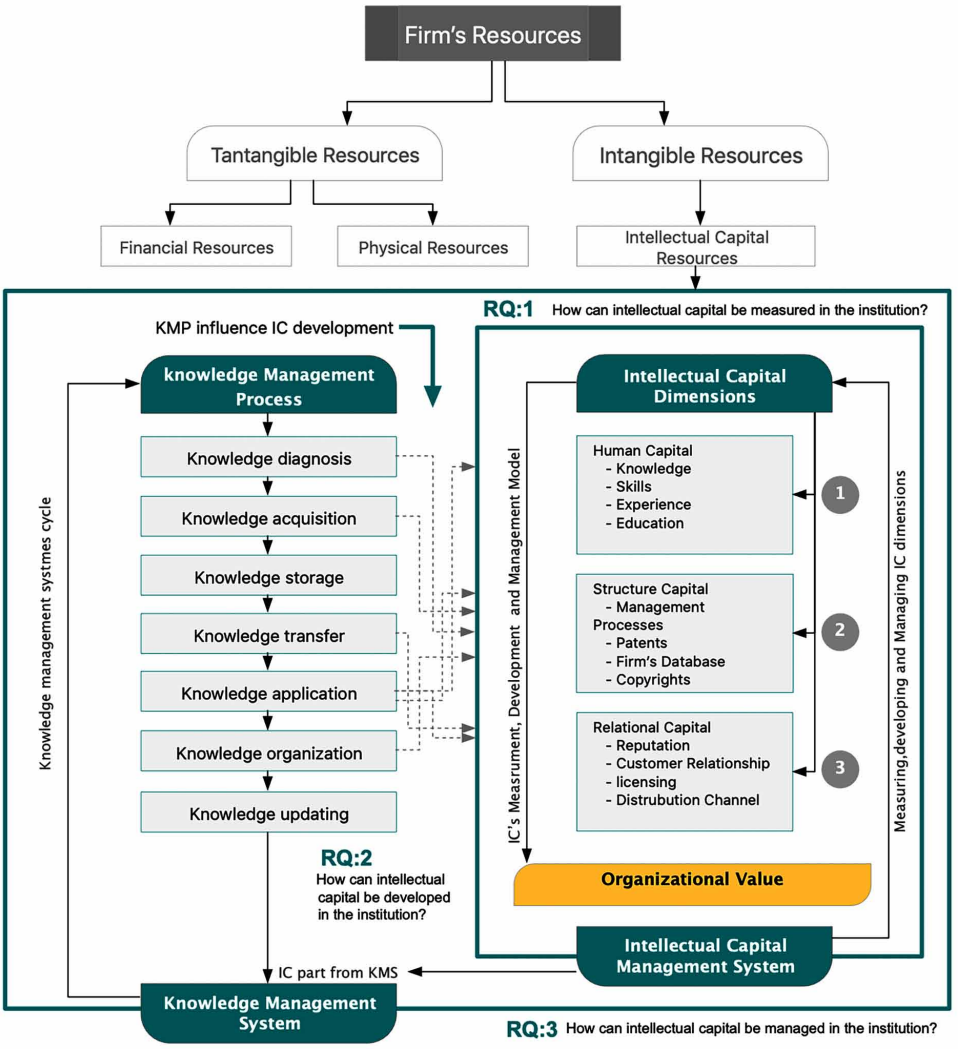
Based on the framework, a firm's resources are divided into tangible and intangible resources. Tangible resources are financial resources and physical resources, whereas intangible resources are limited to intellectual capital, which is the basis of this research. The conceptual framework is structured to establish a relationship between intellectual capital and knowledge management. In a research study related to this subject, the researchers found a mutual relationship of cause and effect between knowledge management and intellectual capital (Seleim & Khalil, 2011). Based on the research and studies, the researchers found that there is a relationship and that one of them is part of the other. The link between the two concepts is explained below.

Knowledge management processes directly affect the development of intellectual capital. For example, the process of knowledge diagnosis works to search for knowledge within an organization and compare it to the current knowledge assets to identify the type of knowledge the institution requires. Then comes the process of acquiring knowledge within the institution, whether from internal or external sources. The process of storing knowledge refers to saving knowledge in different ways. The rest of the processes—knowledge transfer, implementation, and updating—directly lead to increasing the capabilities and competencies of knowledge workers. This increase results in the need to invest in human capital, which reflects the values of the organization and aids in attracting the best knowledge workers from the knowledge market, which is characterized by high competition.

Therefore, each process of knowledge management contributes to the development and improvement of human capital, structural capital, and relational capital. Similarly, whenever there is a development or improvement of the components of intellectual capital, it has led to improvement as well in knowledge management processes which then increase value of knowledge at the institution and the institution's ability to benefit from that knowledge at any time. The use of information technology in knowledge management systems plays a major role in maintaining knowledge, as it improves the expansion of organizational memory and the retrieval of stored information and knowledge.

In this figure below, the researchers observe how intellectual capital management a part of knowledge management is. The researchers can say that intellectual capital can be measured, developed, and managed during the knowledge management process itself. Figure 1 illustrates the conceptual frame work for this research.

Figure 1. Conceptual framework



RESULTS AND DISCUSSIONS

Measuring Intellectual Capital

Most prior studies have acknowledged that measuring intangible assets, especially cognitive assets, is difficult. But it was necessary to measure these assets with specific tools for several reasons. The most important, as the researchers mentioned earlier, is

to help senior management make the right decisions to raise the value of the institution (Marr, Gray, & Neely, 2003). The Ministry of Education has measured several aspects of intellectual capital. The most important of these are the measurements of knowledge and skills and satisfaction of employees with their current jobs and performances. The measurement process is also linked to technology through the introduction of an electronic system for measuring annual employee performances.

As for measuring knowledge and skills, previous results have shown that there is an interest in measuring staff knowledge and abilities because tests or interviews are conducted prior to recruitment. This means that the Ministry is working to attract the best expertise, knowledge, and human talent by preparing a set of criteria for the human resources department for different jobs and specializations and holding specialized tests and interviews for applicants. Evidence of this is that most of the staff possess the qualifications and skills for the jobs they currently occupy. This is confirmed by Kaplan and Norton in the Balanced Scorecard model (Van Grembergen & De Haes, 2009), which takes into account the intangible elements of the organization such as expertise, knowledge, skills, and employee satisfaction in order to improve the performance of the organization.

Uzuegbunam, Liao, Pittaway, & Jolley (2017) assert in another study that a person's cognitive abilities are a key resource for any project for which there is a strong relationship between the success of the project and its human resources expertise. The study also pointed out that the educational attainment of the attracted human resources is closely related to the success of any institution's strategy and that this must be accompanied by experience and not only a scientific certificate.

Almost all interviewee confirmed that pre-function diagnostic tests are very important. The Ministry of Education already prepares a diagnostic test for the applicants to verify the availability of the required qualifications, skills, and experience, and an applicant may be subject to more than one test to be eligible for a job. This is indeed confirmed by a study conducted by Highhouse & Rada, (2015) on the importance of employment tests before obtaining jobs. They tested the capabilities and scientific knowledge and showed that these significantly affect the performance of the institution and its ability to achieve its strategic objectives.

As for measuring satisfaction, employees' satisfaction and a sense of belonging to the jobs and places of work and a conviction of what is accomplished by it is very important to achieving the strategy of the institution and improving its performance. The Ministry of Education staff who participated in the interviews confirmed the importance of job satisfaction and its ability to achieve value for the institution, although some are dissatisfied but believe in it. In support of this finding, a study

shows the relationship between employee satisfaction and customer satisfaction. The study revealed that the employee who is satisfied with his or her work, is proud of the institution, and works for it with all dedication and loyalty which results in a satisfied customer (Chi & Gursoy, 2009).

The Balanced Scorecard, which aims to measure the performance of the organization and ensure the successful implementation of the strategy (Van Grembergen & De Haes, 2009), contains a number of axes, among which is the main focus on customers and their satisfaction by providing new services and products or improving existing products. The data obtained shows that the Ministry measures customer satisfaction, especially satisfaction with the electronic systems used, as these are the basis of all transactions in the Ministry and ensure that it conforms to the best international practices. It measures satisfaction, ease of access, speed of problem resolution, and quality to ensure that all systems are available 24 hours a day.

The continuation of the Ministry's measurement of job satisfaction of its employees through questionnaires about the availability of services for employees is part of its measurement of intellectual capital. This is confirmed by a study of the impact of intellectual capital on employee satisfaction (Longo & Mura, 2011), especially structural capital, which includes services, databases, infrastructure, and information systems. The more these elements are available in good quality, the better the employee returns, and the more the value of the organization rises.

Developing Intellectual Capital

Intellectual capital represents a great asset for the institution if it is given attention and development. Human capital must be enriched in each institution by encouraging employees to engage in training programs and motivating them to innovate. For its part, the institution must provide adequate support to its employees in order to maintain their wealth of knowledge. It is also necessary to rehabilitate employees between one period and another in line with the challenges of the times and with modern technological developments. Many employees have creative and innovative capabilities that simply need to be discovered and developed.

According to the results achieved, the Ministry of Education is concerned with intellectual capital and its development as an important strategic tool and a strong competitive advantage that elevates the institution to achieve its vision, mission, and strategic objectives.

The discussions pertaining to the results divided into three main parts to identify the role of the Ministry of Education in the development of intellectual capital. The first is services and information systems and the extent to which the employee can

access and use them to facilitate the work. The second part includes the development programs provided to the employees, and the last is the work environment and internal cooperation between staff of different departments.

Through the results obtained it became clear that the Ministry of Education is genuinely interested in the work environment in terms of security and providing all the necessities for the work. Most of the interviewees applauded the setting of the work environment and the availability of appropriate hardware and technical tools to complete the tasks, and there was no disagreement. According to our interview with the department directors, the Ministry has always shown interest in this aspect. It is based on the understanding that the success of the work environment depends on the availability of the necessary tools for work, whether these tools are concrete technology or electronic systems.

The Ministry of Education in this regard provides access to all systems of knowledge according to employee clearance levels, and this is what most of the interviewees spoke about. There was some dissatisfaction with delayed access to information because of the lengthy process by which certain information was obtained to complete the work, and time was wasted waiting for it. But in a study about privacy and access to information systems in companies, it was concluded that power is not given to every employee to access all data and information in the systems. There are data that cannot be used. Certain requirements must be met to access the data and employees must be accredited by the direct president (Zhang, Chen, Shang, Zhu, & Liu, 2018).

In terms of development, the development of the intellectual capital of employees in the Ministry of Education was one of the most important observations during data collection. It was noted that there is an extraordinary interest in the development of human resources. Most of the answers indicated that there is already development of knowledge and experience in various ways. Nearly three years ago, the Ministry opened a special building to train staff, including employees of the Ministry of Education, teachers, and all those working in the teaching staff of the Ministry.

In our meeting with the Director of the Department of Training and Professional Development in the Ministry, the researchers identified possibilities for the Ministry and its role in the professional development of employees as well as how to enrich and develop the intellectual capital of its human, structural, and relational types. As the researchers mentioned earlier, Yeoman (2014) suggests that the planning for professional development is the main engine for developing intellectual capital and directing it in the right way. Therefore, the Ministry has planned well and further plan to develop the knowledge and experience of the human element in a way that ensures the sustainability of knowledge and its transfer in the institution.

There are several approaches to professional development. First, is through training programs, which are selected by the employee herself/himself through an electronic training system in which the employee determines the knowledge and skills needed and recorded in the times that she/he deems appropriate for her/him. Second, is also another type of professional development, which is selection by the manager or the senior management of some employees to attend work-related courses or to develop the employees and increase their experience in the field. This involves attending workshops, conferences, or forums either in the UAE or outside the country. The process of developing knowledge is not confined to the employees, but also extends to the executive managers and senior officials in the Ministry. This clearly demonstrates the Ministry's keenness to develop all its employees.

As for internal cooperation between staff of different departments, it is clear to us through the data obtained that the Ministry of Education is interested in relational capital and its development in addition to the development of human and structural elements. The Ministry is always working to involve its staff in committees to develop the skill of teamwork, believing that the transfer of stronger knowledge is not only through groups and cooperation, but virtual cooperation across groups on the Internet. Internet discussion has already proved effective in solving many issues, raising suggestions, and addressing many issues that were difficult to discuss due to geographic or time differences. This is indeed confirmed in a study on the impact of technology-based collaboration on knowledge transfer. The study confirmed that modern methods of collaboration, such as e-learning communities, are major engines of knowledge transfer (Ngoma, 2013).

The results of the analysis also showed cooperation at the level of the group in terms of listening to the opinions of others and considering proposals whether they are applied or not. A study of what is actually presented as proposals by staff has already encouraged many staff to make proposals. The proposals are presented according to the views of the participants through an electronic system for submitting complaints and proposals. It is indeed a significant leap forward for the Ministry to use electronic systems to accept staff opinions so that it has a very valuable database of proposals made by its employees.

Managing Intellectual Capital

In this section, three main aspects of how to manage intellectual capital are discussed. These areas are policies and administrative procedures, organizational structure and how to work within it, and knowledge management strategy. According to the data

obtained, the procedures and policies are fairly clear to some in the Ministry of Education. Policies and procedures are the results, regulations, and administrative laws. Others believe that many policies need to be clarified. One study that has developed a model of intellectual capital maturity and its importance as an institutional improvement strategy states that clarifying all policies and procedures helps to develop a real strategy for the organization by clarifying the objectives of the organization, identifying the actions to be undertaken, and providing a better understanding of what the organization is seeking to achieve and access (Secundo, Elena- Perez, Martinaitis, & Leitner, 2015)

Clarity of procedures, policies, and processes is also followed by clarity of roles and responsibilities. During the interviews, the researchers noted that the roles and responsibilities of knowledge transfer among employees are somewhat unclear and employees have no idea whether the Ministry has knowledge management systems or not. It should be clarified that intellectual capital management is part of knowledge management, which ensures the direction, organization, coordination, and monitoring of activities and procedures directed towards the distribution, use, creation, and formation of knowledge within the organization (Irma Becerra-Fernandez, 2010)

The organizational structure is a network of roles organized in a way that serves the objectives of the organization and directly affects the relationships and roles of all individuals in the organization (Dedahanov, Rhee, & Yoon, 2016) . The organizational structure helps to define the distribution of responsibilities, roles, and authority among individuals, identify the relationships between the president and the subordinate, delegate authority and design work control procedures, ensure internal communication within the organization, and determine how all employees can participate in decision-making according to their functional levels (Kribikova, 2016).

The organizational structure of the Ministry of Education is clear, explicit, and specific. According to the employees, there is an organizational structure, but the employees are only allowed to make decisions aligned with their level of work, based on experience. Employees are prohibited from making any decisions concerning areas or tasks higher than their specialty. It is clear that the decision-making process of the Ministry is codified and specific because it depends on the success or failure of the processes that are based on decisions. A study by Kotalik and colleagues (2014) stresses that decision-making in institutions must be based on vision and mission, an in-depth study should be conducted before making any decision, and all possible solutions and results should be presented before making the best decision on the subject of discussion.

As for knowledge management strategy, most of the responses indicated that employees are aware of the Ministry's strategy, objectives, plans, and initiatives. The official website of the Ministry and each department works to achieve its operational and strategic objectives. Only a small percentage replied that the Ministry is working to achieve certain goals but have no knowledge of whether these goals are designed to achieve the strategic objectives or not. This, of course, is contrary to reality, since the annual employee objectives are developed to achieve initiatives and activities that contribute to the achievement of the Ministry's strategic objectives. In interviews, departmental managers show that they are already sharing the strategic plan with their employees by selecting the appropriate objectives to work on and evaluating them within the annual performance management system program.

The researchers asked about the knowledge management systems in the Ministry. Is there a real strategy for knowledge management? Almost all the answers from supporters and opponents confirmed that there are systems at the departmental level, but some responded that there are no systems and databases that can be consulted when needed. When interviewing the Director of the Learning Data Center at the Ministry, it was found that the Ministry does not have a specific system called a Knowledge Management System, but there are several systems that contain large amounts of data and can be used at any time. These systems include data management for students, schools, and any institutional processes associated with the Ministry. The Federal Human Resources Authority, which effectively administers all federal government employees, provides a large database that assists employees with accomplishing their work and supports decision-makers in developing human resources and support policies (FAHR, 2018).

From the above, it is clear to us that there is management of intellectual capital in the Ministry of Education. Although there is no approved model for managing intangible assets, there are many effective practices in use. Several policies and procedures have been established to regulate the administrative work of the institution, and the decision-making process is codified and specific and has certain laws.

The organizational structure is very clear and specific between the president and his subordinates. The process of communication with others is also clear through the organizational structure. Finally, it was noted that there is a rapid orientation currently underway in the Ministry toward the management of knowledge of the human element and the use of many systems and techniques that help to create a real database to benefit the Ministry.

CONTRIBUTIONS OF THE STUDY

This study offers several contributions. Firstly, in this study, the MOE identifies its strengths and weaknesses in the areas that assist in the improvement and development of the knowledge management system. This study helps prove that for any organization to succeed, its prime source of assets—intellectual capital—must be in place and in order. The researchers categorized and defined what constitutes the intellectual capital of an organization and what exactly "knowledge management system" means. The communication of this definition within an organization is vital to elicit a clear understanding of how an organization can improve its infrastructure. Through our interviews, the researchers helped give our participants a basic understanding of what their roles in their organization can help achieve and the importance of their presence in the organization.

Secondly, this study emphasizes the importance of knowledge-sharing techniques and tools, the benefits of teamwork and collaboration, and the importance of policies, organizational structure, and the knowledge management strategy. Based on various research papers, the researchers proved the integration of intellectual capital as a part of the knowledge management system. Fink & Ploder (2009) believe that intellectual capital is highly dependent on the proper use of knowledge management processes. Barker (2006) also finds a link between intellectual capital and knowledge management, stating that the practical use of knowledge management processes, including the creation, organization, transfer, storage, and other processes, leads to a significant preservation of the knowledge stock of the workers, improving performance and thus creativity and innovation.

Thirdly, this study as well helps analyse how to measure, manage, and develop intellectual capital from various angles that can be applied to any departments of the MOE. It contributed by assisting employees in working in the areas left untouched and neglected by many departments. The researchers educated the employees working in such delicate areas on how they can improve their work technique and how doing so directly affects the outcomes of their work.

Fourthly, this study helps improve the work ethic at the MOE by gathering insight on the proper use of communication techniques, teamwork and collaboration, services, infrastructure, and the introduction of various development programs. Hence, this study was helpful in eliciting an understanding and management strategy of the organization's intellectual capital in all frameworks, which in turn affects the success of its knowledge management system.

Lastly, the researchers would also like to point out that the research described in detail the principles of intellectual capital, the first principle is to help the organization benefit from its intellectual assets and work on managing and investing them in a

well-thought-out and correct manner. The second principle of intellectual capital in the organization is structuring the intellectual capital within a particular model, the available databases, and their use. Last principle is providing all the resources, material, moral resources to build a model for the management of intellectual capital in the organization. A review of previous studies and scientific research in this area has also contributed greatly to clarifying the concept of intellectual capital and its components and how it can be a part of knowledge management.

CONCLUSION

Different organizations adopt different methods and practices, and the MOE has the capacity to improve the skills and expertise of its employees. One of the creative features of the MOE is that it has a specific performance management strategy and various development and training programs. The Ministry is always working to involve its staff in committees and groups to develop teamwork skills, believing that the transfer of knowledge can be achieved through groups and cooperation. Additionally, the organization engages in virtual cooperation across groups on the Internet, which has already proven effective in solving many issues, generating suggestions, and discussing issues that had previously been difficult to discuss due to geographical dimensions or time zone differences. In addition to teamwork and collaboration, the MOE has adopted various other methods, such as the measurement of employee satisfaction, which is one of the most important methods of measuring intellectual capital and the extent of its impact on the performance of an organization, as employee welfare and satisfaction are key factors in raising the value of an institution.

The three subsections of the research question on how to measure intellectual capital—knowledge and skills, satisfaction, and the performance management system—helped elicit a starting point on how to tackle our thesis. As a whole, the first part helped us gain insight into what one does and what the participant's duties are, the second part explored how well maintained and protected the assets in the organization are, and the last part examined the MOE's performance management system as a whole. These three areas focus on how intellectual capital is positioned within the workplace and whether the organization is doing its part to measure and maintain its assets.

The paper aims to inform the readers that intellectual capital has a huge impact on the workplace environment of an organization, including not only the services offered but also the inner workings of the organization that provides the services.

The study demonstrates that with the proper procedures, it is possible to monitor and maintain organizational intellectual capital in its best form. Nowadays, many organizations skip the basic step of organizing their structure without knowing the consequences. Using a qualitative method, the interviews in this study shed light on how the participants manage the assets within themselves. Using the data obtained, the study has come up with a model that can be used as a framework for employees to cross-check with their working procedures.

This study is intended to justify that if an organization is made up of many data management systems that constitute the entire knowledge management system (like at MOE), a wide array of procedures and detailed attention is required, which can be managed through three easy steps—the proper measuring, managing, and developing of intellectual capital.

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Index

F

G

H

I

K

L

M

N

P

Q

R

S

T

U

V

W