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Mindful Learning: Children's Developing Theory of Mind and Their Understanding of the Concept of Learning

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Abstract
Applying self-regulated learning in early childhood classrooms assumes that children are metacognitive learners by default, an assumption which is deeply flawed. The theoretical advancement in theory of mind development provides new perspectives in understanding the challenges young children are facing in comprehension of mental states in learning. The present study proposed that theory of mind development is critical for children to engage in mindful learning, which refers to the learning during which the learner is consciously aware of own mental states and the changes in them, both motivational and epistemic mental states. This dissertation launched an investigation of children's developing understanding of learning as a process of mental representational change from a theory of mind framework. The goal was to pinpoint the mental properties that are essential to children's understanding of learning, examine their relationship with theory of mind ability including false belief understanding, and outline the developmental trajectory of mindful learning during preschool and early elementary school years. Six studies focused on children's understanding of knowledge change in learning, children's understanding of beliefs about knowledge state in learning, and children's understanding of learning intention. Simple stories concerning various learning scenarios were designed to address children's understanding of the concept of learning. The results found that vi young children first understood learning as a behavior independent of knowledge change. Changes in children's understanding of learning were correlated with their emerging theory of mind ability, and developed through preschool and early elementary school years. Around the time of school entry, children began to appreciate that learning is a representational knowledge change in the mind, and people decide whether to learn based on their belief about knowledge state. They also began to understand that learning intention is often related to learning outcome; however, intention is neither a sufficient nor a necessary condition for learning. Based on the data on a theory of mind battery and those from the literature, it was suggested that children in different cultures might develop theory of mind understanding via different routes. The theoretical implication of mindful learning was discussed in relation with theory of mind, metacognition, and personal epistemology. The practical implication of mindful learning was discussed in the context of early childhood pedagogy and curriculum as well as school readiness.

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ABSTRACT

MINDFUL LEARNING: CHILDREN'S DEVELOPING THEORY OF MIND AND THEIR UNDERSTANDING OF THE CONCEPT OF LEARNING

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Supervisor: Douglas A. Frye

Applying self-regulated learning in early childhood classrooms assumes that children are metacognitive learners by default, an assumption which is deeply flawed. The theoretical advancement in theory of mind development provides new perspectives in understanding the challenges young children are facing in comprehension of mental states in learning. The present study proposed that theory of mind development is critical for children to engage in *mindful learning*, which refers to the learning during which the learner is consciously aware of own mental states and the changes in them, both motivational and epistemic mental states. This dissertation launched an investigation of children's developing understanding of learning as a process of mental representational change from a theory of mind framework. The goal was to pinpoint the mental properties that are essential to children's understanding of learning, examine their relationship with theory of mind ability including false belief understanding, and outline the developmental trajectory of *mindful learning* during preschool and early elementary school years. Six studies focused on children's understanding of knowledge change in learning, children's understanding of beliefs about knowledge state in learning, and children's understanding of learning intention. Simple stories concerning various learning scenarios were designed to address children's understanding of the concept of learning. The results found that young children first understood learning as a behavior independent of knowledge change. Changes in children's understanding of learning were correlated with their emerging theory of mind ability, and developed through preschool and early elementary school years. Around the time of school entry, children began to appreciate that learning is a representational knowledge change in the mind, and people decide whether to learn based on their belief about knowledge state. They also began to understand that learning intention is often related to learning outcome; however, intention is neither a sufficient nor a necessary condition for learning. Based on the data on a theory of mind battery and those from the literature, it was suggested that children in different cultures might develop theory of mind understanding via different routes. The theoretical implication of mindful learning was discussed in relation with theory of mind, metacognition, and personal epistemology. The practical implication of mindful learning was discussed in the context of early childhood pedagogy and curriculum as well as school readiness.

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CHAPTER ONE

Introduction

> The teacher was playing a number game with children in a preschool classroom. She needed a child as the "helper" to give prizes to the kids who recognized the number on a card correctly. Bobby was very enthusiastic to be the helper and hand out prizes. The problem was that Bobby did not know any numbers. He simply gave everyone a prize no matter whether they were correct or not. When he was reminded that he could only give a prize when it was the correct number, Bobby said: "It doesn't matter, they know the numbers."

As odd as it seems, this is a real life example of classroom teaching and learning in preschool. Unfortunately, there is no learning taking place here. For Bobby, "knowing the numbers" simply means one can call out a number, any number, to be exact. Such a *physicalized* idea of knowing (Miscione, Marvin, O'Brien, & Greenberg, 1978; Piaget, 1929) fails to recognize knowledge is part of our mentality and "doing" does not equal to "knowing." The consequence of such failure is that Bobby and his classmates missed a learning opportunity to gain new knowledge about numbers.

Knowledge is a form of mental representation that reflects an accurate relation between the mind and the external physical world. Mental representation is not a copy of the reality (Wellman, 1990); therefore it may or may not reflect the reality accurately. When mental representation is distorted or inaccurate, it becomes false belief. Only the mental process that leads to the acquisition of an accurate representation of the reality, i.e., knowledge, can be classified as learning. To a certain extent, learning new knowledge "depends on an understanding of the representational change" (Gopnik & Astington, 1988, p. 26), since "[i]t is hard to imagine teaching someone who was unable to recognize that they had been wrong" (p. 27).

Bobby is an example of a learner who is yet to reach the stage of *mindful learning*. Children absorb information from the outside world constantly from early on. However, it is arguable whether the early change in skills and behaviors is learning in terms of conscious mental processing. A person who is not consciously aware of one's own knowledge change and mental effort in learning can nevertheless acquire new knowledge. Yet, only a learner with explicit understanding of the mental changes in learning is able to effectively monitor, direct, and control his or her own learning and therefore maximize the benefit from teaching activities such as the above mentioned episode. Although there is evidence that young children, even infants, have an implicit awareness of others' mental states and can use that information to facilitate their own learning (Baldwin, 1995; Birch & Bloom, 2002; Bloom & Tinker, 2001; Diesendruck, Markson, & Bloom, 2003; Harris, 2007; Meltzoff, 2005; Sabbagh & Baldwin, 2001; Saylor & Troseth, 2006; Tomasello & Farrar, 1986), little is known about children's explicit understanding of the mental activities and processes during learning.

1.1 Metacognition and Self-Regulated Learning

1.1.1 The Concepts

While there is little research focusing directly on children's explicit understanding of mental properties of learning, the learners' awareness and control over learning process have been the focus of the research on *metacognition* and *self-regulated learning* for several decades. Despite the fact that it has been part of the everyday discourse in educational psychology for quite a while, it is difficult to give a unanimous definition to metacognition. According to Flavell (1979, 1987), metacognition consists of both metacognitive knowledge and metacognitive experiences of regulation. Metacognitive knowledge is the knowledge about cognitive processes, including knowledge of person variables, task variables, and strategy variables. Knowledge of person variables refers to general knowledge about how we learn and process information, as well as specific knowledge of one's own learning process. Knowledge of task variables refers to knowledge about the task characteristics, along with the awareness of the processing demands of the task. Finally, knowledge of strategy variables refers to knowledge of both cognitive and metacognitive strategies. Metacognitive experience is the comprehension and implementation of strategies for goal attainment.

Another widely cited framework for metacognition was proposed by Brown (1978). Her framework also suggested two components of metacognition: knowledge of cognition and regulation of cognition. Knowledge of cognition is the understanding of one's own memory and the way one learns. Paris and colleagues (Paris, Cross, & Lipson, 1984) suggested the knowledge component of metacogntion includes three aspects: declarative knowledge, which is the knowledge about one's general processing abilities; procedural knowledge, which is the knowledge of how to successfully solve problems; and conditional knowledge, which is the knowledge such as when to employ certain strategies. The regulation of cognition refers to constructs such as planning, monitoring, and evaluation of learning.

Metacognition is mostly discussed in the context of learning, referring to the concept of self-regulated learning. Paris and Newman (1990) defined self-regulated learning as learning that involves planfulness, control, reflection, competence, and independence. Zimmerman (1998) defined self-regulation as self-directedness and performance control before, during, and after a task activity. The nature of the relationship between metacognition and self-regulated learning, again, is disputable. To some, self-regulation is a subcategory of metacognition. Flavell's metacognitive experience and Brown's regulation of cognition contain elements of self-regulation. Borkowski (1996) described three interrelated aspects of metacognition: knowledge, judgments and monitoring, and self-regulation, the first of which overlaps with Flavell's (1979) knowledge about person, task, and strategy. Judgments and monitoring refer to the processes occurring while performing a task, such as a feeling of knowing, or comprehension monitoring. Self-regulation refers to adapting strategies and skills to meet the changing demands.

Other theorists such as Zimmerman (1995), however, argued that self-regulation covers more ground than metacognition, mainly motivational components such as self-efficacy. As a result, people tend to distinguish metacognition and self-regulation in pragmatic terms when they use the two as distinct concepts. For example, Kuyper, van der Werf, and Lubbers (2000) defined metacognition as the use of cognitive and metacognitive strategies in learning, i.e., the control over learning *process*; and self-regulation as the motivational and behavioral aspects of learning, i.e., the control over the learning *behavior*.

1.1.2 Metacognition and Achievement

Students' metacognitive development is crucial to academic success (McCormick, 2003). On the one hand, good schooling should be the "hotbeds of metacognitive development" (Flavell, 1987, p. 27), since it provides the opportunity for self-conscious learning. Instructional studies (Boulware-Gooden, Carreker, Thornhill, & Joshi, 2007; Jacobs, 2004) demonstrated that incorporating metacognitive thinking in teaching benefited students' metacognitive development. On the other hand, metacognitive self-regulation significantly predicted later school achievement in longitudinal studies (Nota, Soresi, & Zimmerman, 2004; but see Kuyper et al., 2000, for counter evidence), since "students who can self-regulate cognitive, motivational, and behavioral aspects of their academic functioning are more effective as learners" (Nota et al., 2004, p. 198).

Swanson (1990) found that metacognitive knowledge compensated for lower overall aptitude level in problem solving. He picked 4th and 5th grade students with either high or low aptitude measure scores and gave them a metacognitive questionnaire and problem solving tasks. The metacognitive question included 17 questions about person variables (such as "Ryan is 5 years old and knows all about dinosaurs. Ryan's father does not know a lot about dinosaurs. If both Ryan and his father read a book about dinosaurs, who would remember the most? Why?"), task variables (such as "A group of individuals was going to solve a problem on a computer. One individual owns a computer at home. Do you think the ability to solve the problem will be easier or harder for someone who does not own a computer? Why?"), and strategy variables (such as "How do children figure out things, like how to do something?"). He found that high-metacognitive individuals outperformed low-metacognitive individuals in problem solving regardless of their overall aptitude level. The high-metacognitive/low-aptitude children performed significantly better than low-metacognitive children with higher overall aptitude scores. The results suggested that metacognitive knowledge and aptitude are two distinctive constructs and the metacognitive knowledge is more closely related to problem solving.

1.1.3 The Origin of Metacognitive Self-Regulation

Research on metacognitive development mainly focused on older children, adolescence, and adults (Georghiades, 2004). According to classic Piagetian theory, the ability to reflect on one's own cognition requires formal operational thoughts (Brown, 1987; Piaget, 1976), which explains why young children could hardly benefit from metacognitive instructions (Adey, Shayer, & Yates, 1989). However, children's "developing sense of the self as an active cognitive agent and as the causal centre of one's own cognitive activity" (Flavell, 1987, p. 26) might be one of the changes that contribute to children's acquisition of metacognition. As Kuhn suggested, "understanding knowledge as the product of human knowing is a critical first step in the development of epistemological thinking" (Kuhn, 2000a, p. 178).

Research on children's theory of mind (ToM) development (for reviews, see Astington, 1993; Carpendale & Lewis, 2006; Flavell, 1999; Flavell & Miller, 1998; Frye & Moore, 1991; Mitchell & Riggs, 2000; Perner, 1991; Wellman, 1990) provides just such a conceptual framework in understanding the emergence of metacognition in children. Focusing on children's understanding of how the mind works, ToM research breaks ground for the inquiry of the origins of understanding the mental characteristics of learning (Kruger & Tomasello, 1996; Olson & Brunner, 1996). It is argued that mindreading ability develops prior to metacognition (Carruthers, 2009). A longitudinal study (Lockl & Schneider, 2007) found that children's ability to attribute false belief at 3 and 4 years of age predicted their metamemory ability at 5 years of age, controlling for language abilities. The authors argue that the representational ToM is the precursor of metamemory, and suggest that better understanding of one's own mentality might contribute to better metacognitive monitoring and regulation. A study with preschool children found moderate correlation between metacognitive regulation and early ToM development (Sperling, Walls, & Hill, 2000). The next section turns into the discussion of the impact of ToM on children's understanding of learning.

1.2 Mindful Learning from a Theory of Mind Perspective

1.2.1 Theory of Mind (ToM)

ToM research in developmental psychology deals with the origins of children's comprehension of mental states. Children are credited with ToM if they understand that, firstly, mind exists and people have mental states such as knowledge, belief, desire, and intention; and secondly, causality exists between mental processes and actions and people's behavior can only make sense in a framework of mental state attribution. Mentality is not transparent to children. It takes several years for children to learn that people have mental states that are different from their own, or inconsistent with the physical reality. One influential account (Wellman & Woolley, 1990) suggested that by the third year of life children acquire a *desire psychology* that helps them to make sense of people's actions in desire terms. However, it is not until the age of 5 do children begin to use *belief psychology* to understand the epidemic mental states such as belief, knowledge, and ignorance, and use desire-belief reasoning to explain behaviors.

A sizable portion of ToM research has been focused on the understanding of false belief. In Wimmer and Perner's (1983) original study, children were told stories about chocolate being put in one location with a boy named Maxi present and then relocated to another with Maxi absent. Questions were asked about Maxi's knowledge state, such as whether he knew where the chocolate was upon returning to the room (the character's ignorance), where he thought the chocolate was (the character's false belief), and where he would look for the chocolate (prediction of actions). A comprehensive meta-analysis (Wellman, Cross, & Watson, 2001) showed that false belief understanding developed during preschool period between 3 to 5 years of age (but see Onishi & Baillargeon, 2005 on babies' understanding of false belief, also see Perner & Ruffman, 2005 for counterargument).Three-year-olds would consistently respond that Maxi *knew* where the chocolate was and would look for it at the new location. By 5 years of age children began to understand that without the perceptual access, Maxi was ignorant of the true location, or held a false belief about it. This line of research demonstrates children's initial thoughts of what knowledge is and how knowledge changes. Knowledge and false belief are both mental representations. The difference is that while knowledge is justified belief, false belief is not. The studies in false belief are especially informative because they reveal the development in children's understanding of the verifiable mental representation in knowledge construction, as well as the representational change in its relation with the reality.

Children's understanding of their own knowledge state change developed around the same time as their understanding of other people's knowledge state. Gopnik and Astington (1988) showed children a candy container and asked what they thought was inside. Then the actual contents were revealed. Surprisingly, they turned out to be pencils instead of candies. Children were then asked what they initially thought was inside. Five-year-olds could correctly remember their first response, but 3-year-olds tended to say they knew there were pencils inside before seeing the actual contents. When they were asked to predict what a naïve person would think was in the container, 3-year-olds again tended to say pencils. In addition to confirming that younger children have trouble understanding the relation between knowledge formation and perceptual access, this result also suggests younger children have trouble keeping track of changes in their own knowledge. Gopnik and Astington (1988) brought attention to the implication of children's understanding of representational change for teaching and learning. To benefit from instructions and gain new knowledge, the learner needs to represent his or her own past knowledge states and be aware of being wrong or ignorant, without which, there is no basis to understand that learning has occurred.

1.2.2 ToM Measure

Based on a meta-analysis of ToM measures, Wellman and Liu's (2004) developed a battery of five tasks measuring the developmental sequence of ToM. From the easiest to the most difficult, the five tasks are: 1) *Diverse Desires*--the child judges that the self and another have different desires about the same object; 2) *Diverse Beliefs*--the child judges that the self and another have different beliefs about the same object, when the veracity of the belief is unknown to the child; 3) *Knowledge Access*--the child sees what is in a box and judges the knowledge of another who has not seen the contents of the box; 4) *Contents False Belief*--the child judges another's false belief about what is in a distinctive container when the child knows what is in the container; 5) *Hidden Emotion*--the child judges that a person can have one emotion internally but can display a different emotion externally. An optional sixth task, *Explicit False Belief*--the child judges another's false belief about the location of an object when the child knows the true location, shares the same difficulty level with *Contents False Belief*.

Data from the sample of 75 children indicated the five tasks formed a Guttman scale with high reproducibility (Green's coefficient of reproducibility = .96, values greater than .90 indicate scalable items) and acceptable scalability (Green's coefficient of scalability = .56. This index tests whether the observed coefficient of reproducibility is greater than chance alone, values greater than .50 are significant) (Green, 1956). Sixty out of the 75 children fit the sequence of the five-item scale exactly. The scale score correlated with age in months with $r(75) = .64$, $p < .001$. A Rasch model based on item response theory revealed same sequence in the difficulty level of 5 tasks, with roughly evenly spread item scale scores. The items fit the scale well.

The advantage of using a battery of tasks instead of a single false belief task as an index of mental state understanding is that the battery captures a broader construct of ToM development and provides a scale or continuum on children's understanding of different mental states. Although normative data are yet to be obtained for this scale, Wellman and Liu's (2004) battery reveals a progressive understanding of ToM in typically developing Western children. Replications using this scale were obtained from samples of autistic and deaf children and normally developing children from other countries (Peterson, Wellman, & Liu, 2005; Wellman, Fang, Liu, Zhu, & Liu, 2006). Roughly the same difficulty sequence was found in those samples, with two exceptions: Chinese children passed the *Knowledge Access* task earlier than the *Diverse Belief* task (Wellman et al., 2006); and autistic children passed the *Hidden Emotion* task earlier than the *Content False Belief* task (Peterson et al., 2005).

1.2.3 Mindful Learning

As defined by social psychologist Ellen Langer (1989, 1997), *mindfulness* emphasizes the quality of awareness and being reflective. Langer argues that the concept of *mindfulness/mindlessness* has broad implications in everyday behavior, including learning. However, instead of focusing on the conceptual foundation of learning, that is, the representational change, Langer's idea of *mindful learning* focuses on the general cognitive resource allocation such as attention and executive control. The term *mindfulness* has since been adopted by psychiatrists and mental health professionals in referring to the fully-present-in-the-moment meditation and self-regulation of attention (Bishop et al., 2004; Siegel, 2007).

Salomon and Globerson (1987) extended the idea of mindfulness into learning and transfer. They recognize that the "volitional, metacognitively guided employment of non-automatic, usually effortful processes" (p. 625) in learning is the mid-level construct that can bridge what people actually learn and what they could possibly learn. By taking the "high road of learning" (p. 630), mindfulness compensates for automatic skill employment and maximizes the learning potential. In Salomon and Globerson's term, mindfulness refers to metacognitive traits, capacities, and strategy use.

Mindful learning in the present study draws inspiration from Langer's original work, yet distinguishes itself from the previous meanings. Similar to Langer's concept, *mindful learning* addresses not the behavioral aspects of learning, but the higher level thinking in learning. Nonetheless, unlike Langer's emphasis on mental effort allocation or clinical psychologists' emphasis on insight and openness, *mindful learning* in this study focuses on children's conceptual development of what learning is.

The present study proposes that *mindful learning* is a prerequisite of metacognition. Children need to appreciate learning as a mental process before they can progress to learn how to monitor and control their own learning. *Mindful learning* addresses the issue of knowledge and learning from a ToM perspective that is prior to metacognitive monitoring and regulation of learning. To some extent, *mindful learning* overlaps with the knowledge aspects in the metacognition research (Kuhn, 1999, 2000a; Wellman, 1985), especially with the knowledge of person variables in Flavell's terminology. However, *mindful learning* does not simply focus just on general person variables, but specifically on mentality, which concerns more fundamental aspects in children's understanding of learning that provide the building blocks for their later engagement in metacognitive learning.

1.2.4 Mindful Learning from a ToM Perspective

Traditionally, learning theory has been focused on explicit cognitive strategies, language comprehension, and the like. The mind is rather seen as a file cabinet or a container that stores knowledge (Bereiter, 2002). Folk expressions in English, such as *in the back of somebody's mind, on somebody's mind*, or *off the top of somebody's mind* all refer the mind as a location instead of an agent. Such a physicalized idea of the mind fails to see the mind as an active, self-propelled, and motivated driving force in learning. Yet, learning as knowledge change, at least in terms of the declarative knowledge (Bloom, 1956) or factual propositions (Ryle, 1949), requires an active mental involvement.

The process has to do with how the information enters our minds through attention and intention, and forms propositional representations such as belief and knowledge. Being knowledgeable does not simply mean how many data one can hold in the brain-as-a-container, it rather means developing a new view of mind that constructs knowledge (Olson & Katz, 2001). Only when a learner is consciously aware of one's own mental states and the changes in them, both motivational and epistemic mental states, could he or she realize the knowledge deficit and the necessity to learn; therefore become teachable.

ToM as a "core human cognition…shapes human thoughts and learning" (Wellman, 2004, p. 2). It is one of the essential evolutionary achievements, if not the most important one (Tomasello & Rakoczy, 2003), that make us human. Through facilitating the transmission of information among individuals and from generation to generation, ToM has been attributed to the construction of our culturally embedded social mind (Bjorklund, 2002; Premack & Premack, 1996; Whiten, 1999). The ability to view people as intentional agents distinguishes human learning from other animals'. For example, it is suggested that true imitation, in which the observer understands the intention of the demonstrator, may be limited to humans and (perhaps) the great apes (Whiten, 1998). Only when the learner takes an intentional stance (Dennett, 1987), could she understand: "Why is mommy moving her hands about with those long strings in that way? Because she is trying to show me how to tie my shoelaces" (Bjorklund & Bering, 2002, p. 359).

Current interests in understanding the mental properties of learning focus on categorizing pedagogy based on the mental involvement of the teacher and the learner, as well as the teacher's concept of the learner's mind (Kruger & Tomasello, 1996; Olson & Brunner, 1996; Premack & Premack, 1996). For children to benefit from self-regulated learning, however, it is their own understanding of mental processes in learning that matters. Only recently have researchers begun to explore what children themselves know about the mental processes involved in teaching and learning (e.g., Frye & Ziv, 2005; Sobel, Li & Corriveau, 2007; Ziv & Frye, 2004).

Understanding the knowledge change is the first step in *mindful learning*. "Learning, …is defined as a change in long-term memory" (Kirschner, Sweller, & Clark, 2006, p. 75). What has been learned becomes part of the learner's knowledge. The learner learns something if her knowledge state changes from not knowing to knowing; she does not learn if otherwise. Unless the learner forgets, she would not experience learning the same knowledge again.

What distinguishes knowledge from behavior is that knowledge is a mental property. A behavioral marker often is the explicit expression of knowledge. For example, a person can write a letter *O* because she *knows* how to write it. However, a person who does not know how to write a letter *O* can nevertheless draw a circle that perfectly resembles the letter *O*. A behavior that resembles the explicit expression of knowledge without the mental representation does not count as knowing. And the process leading to such a behavior without genuine knowledge change does not count as learning either. A mindful learner should be able to distinguish learning from behaviors without representational change.

A mindful learner understands one may or may not have a true belief about one's own knowledge state; but it is the belief, not the actual knowledge state, that determines the learning intention. A person would only try to learn when she knows about her ignorance; she would not try to learn, though, when she assumes she knows while in fact she does not. In the latter case, the person still holds a mental representation of the subject matter, only it is not justified. Maxi in Wimmer and Perner's (1983) chocolate story had an initial belief about the location of the chocolate, which became outdated after he came back from outside of the room. It is certain that at least Maxi's first reaction back in the room would not be trying to open each and every one of the containers, cupboards, or any other hiding places looking for the chocolate. Since he already had that knowledge, as outdated as it was, he would only go straight ahead to the location he thought it was.

Another kind of false belief is to underestimate actual knowledge. When a person does not know she actually knows, she might set out to learn something, which turns to be unnecessary. For example, at times one may find herself can actually sing a song, but the title of the song simply does not register. When being asked whether she could sing a song with the particular title, the person is most likely to say no. Such a false belief about the knowledge state may lead to the intention to learn the song, only to find out later it would not be necessary.

Unlike teaching, in which both the awareness of knowledge difference and intention to teach are necessary (Frye & Ziv, 2005), knowledge change is the necessary and sufficient condition for learning. For learning to happen, the learning intention is not necessarily required. On the one hand, people learn through intentional practice, imitation, and paying attention to the teacher's instructions. When learning is accompanied with intention, the learner is aware of the learning process and has control over. On the other hand, a learner can gain new knowledge without a learning intention, either through pure discovery or through implicit learning. For example, a person might resist learning a song on the radio, but still ends up humming the melody afterwards (Sobel et al., 2007).

According to Searle (1983), intention is causally self-referential, meaning a causal relation exists between intention and the intended result. In this case, however, using the causally self-referential framework alone to explain learning could even lead to a mistaken understanding that since the person actually learned the song, he must have intended to do so at the first place. Only a mindful learner acknowledges the multifaceted effect of intention on learning and understands intention is neither a sufficient nor a necessary condition of learning.

To summarize, children become mindful learners when they understand that learning is the representational change from ignorance to knowing; actions resembling a learning event without the knowledge change do not count as learning. They also need to know that the learner's belief about one's own knowledge state determines whether or not one would try to learn; therefore the intention would seem contradictory to the actual knowledge state in the case of false belief. Mindful learners further recognize the complex causal relationship between the learning intention and the learning outcome and understand intention is neither a sufficient nor a necessary condition of learning.

1.2.5 Mindful Learning and Personal Epistemology

Research in personal epistemology (Burr & Hofer, 2002; Kuhn & Weinstock, 2002) explores people's thoughts on knowledge construction and belief. Inspired by the inquiry into the nature of knowing and knowledge, people in this area are interested in topics such as "beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs" (Burr & Hofer, 2002, p. 201). *Mindful learning*, however, comes from an inquiry into children’s mental state understanding. The two research streams found themselves merging on the topic of children’s confusion on false belief.

“Understanding knowledge as the product of human knowing is a critical first step in the development of epistemological thinking…” (Kuhn, 2000a, p.178). By the age of 3, children have some appreciation of people being knowers. At the age of 4, a milestone achievement emerges when children realize that people’s behavior is guided by their desires and beliefs, which might be different from their own. Kuhn (1999) categorized the levels of epistemological thinking before and after children achieve false belief understanding as the realist level and the absolutist level. The realist level of epistemological thinking perceives people’s assertions as copies of an external reality; whereas the absolutist level sees the assertions as either correct or incorrect representations of the reality. The transition from the realist level to the absolutist level is a decisive moment in the development of epistemological thinking. It indicates the “transition from simple, unconscious, unreflective knowing about the world to a second-order, or metacognitive, reflection on the knowing claims of self and others” (Kuhn & Weinstock, 2002, p. 126). In other words, the achievement of false belief understanding marks an important milestone of children’s personal epistemological thinking.

1.3 Implications of Mindful Learning

Psychologist Kurt Lewin once said, “There is nothing so practical as a good theory" (1951, p.169). Indeed, much theoretical advancement has provided foundations for effective educational programs and techniques to help children learn better. However, in reality theorists and practitioners do not always speak to each other. The so-called

“Great Divide” (Kuhn & Dean, 2004) between the developmental cognitive psychology and the educational practice frustrates both theorists and practitioners.

1.3.1 Early Childhood Curriculum and Pedagogy

Constructivist theory in education heavily criticizes the discipline-oriented, knowledge transferring teaching and learning; and promotes child-centered, knowledge constructive, society oriented, preparing-for-life education. Various proposals emerge under the influence of constructivism, such as constructivist learning (Jonassen, 1991; Steffe & Gale, 1995), discovery learning (Anthony, 1973; Bruner, 1961), problem-based learning (Barrows & Tamblyn, 1980; Schmidt, 1983), inquiry-based learning (Papert, 1980; Rutherford, 1964), experiential learning (Boud, Keogh, & Walker, 1985; Kolb & Fry, 1975), active learning (Harmin & Toth, 2006; Simons, 1997), and self-regulated learning (Zimmerman, 1990). A number of the curricula and pedagogies designed based on the constructivist teaching and learning theories are oriented to young children, such as the High/Scope’s Plan-Do-Review learning model (Epstein, 2003; Vogel, 2001), and the K-W-L learning model (Ogle, 1986).

As fashionable as they are, it remains an empirical question though whether the level of metacognitive demands of these child-centered, self-regulated learning models is suitable for preschool children (Frye & Wang, 2008). It has been argued that until they understand people as mental agents with thoughts and beliefs, children could not develop internal private dialogues and self-regulating speeches that are essential for metacognitive strategies (Tomasello, Kruger, & Ratner, 1993). Yet the application of self-regulated learning in early education seems to assume that mental state understanding is a default in children, and they should take on the self-regulated learning effortlessly.

For example, the K-W-L model is being introduced to early childhood education as early as preK. It highlights three cognitive steps in self-regulated learning: accessing *what I Know*, determining *what I Want to learn*, and recalling *what I did Learn*, hence K-W-L. Over the years, attempts had been made to modify the K-W-L model to better represent the metacognitive learning processes (e.g., Bender & Larkin, 2003; Korstelnik, Soderman, & Whiren, 1999; Sampson, 2002). Now the K-W-L model is one of the most popular teaching models in early childhood education. To reach the goals of self-regulated learning such as the K-W-L model, however, the learner is expected to be fully equipped with concepts and skills to understand what learning is and to monitor, regulate, and evaluate one's own learning. The learner needs to be aware of his or her own ignorance and knowledge change, to identify the knowledge source and plan and monitor the learning process, and to keep track of when, where, and how their knowledge changed.

The apparent disconnection between the goal of the model and the ability of its intended target reflects a limited understanding of children's metacognitive readiness and educability. Research in *mindful learning* will explore the depth and scope of children's understanding of knowledge and learning, from which the distance to self-regulated learner could be measured.

1.3.2 School Readiness

Mindful learning might as well revise the definition of school readiness. The U.S. National Educational Goals of 1989 (National Education Goals Panel, 1999) emphasizes the importance of preparing children to "start school ready to learn" (p. 1). Despite a fairly broad initial approach to school readiness (Boyer, 1991), much of the subsequent attention has been focused on preparation in specific content areas, primarily those of early literacy and early mathematics. Progress had been made recently in the relation between school readiness and children's regulatory capacity, specifically emotional regulation and executive control (Blair, 2002; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Howse, Lange, Farran, & Boyles, 2003). People argue that young children's behavioral self-regulation (Blair, 2002; Kuhn, 2000b), especially the ability to resist distractions (Howse et al., 2003), is part of the starting point of self-regulated learning and is critical to school success.

Nevertheless, the connection between conceptual mental state understanding and school readiness is brought into attention only recently (Astington, 1998; Astington & Pelletier, 2005; Watson, 1996). According to Astington (1998), mental state understanding helps children to succeed in school through numerous ways, such as representational capacity, language ability, narrative understanding and literacy, intentional learning and objective knowledge, social competence and collaborative learning, as well as the first steps in scientific reasoning. The current account opens up the possibility that an understanding of what learning is may also be an important component of school readiness. If part of the success of formal schooling depends on both the teacher and student having some awareness of the overall point of the activity, the change in understanding should be an advantage for entry to school. Research in children's *mindful learning* would shed light on how early curricula should prepare children to better adapt the institutionally oriented, highly structured formal classroom learning when they go to elementary school.

CHAPTER TWO

Literature Review

2.1 Children's Learning

2.1.1 Infants' and Toddlers' Learning

Mental state understanding is important for children's learning even before they become mindful learners. It is argued that infants have an innate understanding of people as goal-directed agents (Gergely, 2001; Premack, 1990), which enables them to interpret and imitate other people's actions through projecting their own goals (Meltzoff, 2005, 2007, Meltzoff & Moore, 1983, 1997). At the end of the first year of life, infants begin to engage in object-directed interactions with people such as shared-attention and social referencing, indicating they now can share a psychological relation to an object with others (Baldwin & Moses, 1996; Moore, 1996.). By 18 to 24 months, toddlers acquire the understanding of the so-called *motivational mental states*, such as desire and intention (Bartsch & Wellman, 1995; Meltzoff, 1995). The newly acquired skills enable them to learn new words from other people's speech using their desire, eye-gaze attention, and communicative intention as clues (Akhtar & Tomasello, 2000; Baldwin, 1995; Bloom & Tinker, 2001; Diesendruck et al., 2003; Hollich, Hirsh-Pasek & Golinkoff, 2000; Saylor & Troseth, 2006; Tomasello & Farrar, 1986).

Even though babies exhibit implicit mind reading abilities, it is important to differentiate the biologically primary abilities present in early years from the advanced biological secondary abilities (Geary, 1995). From an evolutionary developmental perspective, natural selection leaves human infants with a cognitive skill set necessary for survival. Building on the biological primary abilities, the culturally specific experiences shape the biological secondary abilities through years of rigorous education that is uniquely human. For example, early knowledge of numbers (Lipton & Spelke, 2003, 2004; Wynn, 1992) and oral language (Pinker, 1997) provide the core foundations for cognitive development, but it is the secondary abilities like arithmetic and reading that hold the stake for surviving in the modern human society. The primary abilities are arguably "hardwired" and come natural to babies; the secondary abilities, however, are "painstakingly bolted on" (Pinker, 1997, p. ix). If "prepared learning" (Bjorklund & Pellegrini, 2002) is based on biological primary mind reading abilities, *mindful learning* is arguably based on biological secondary mind reading abilities and develops late in life.

2.1.2 Young Children's Learning

More complicated mind reading abilities represented by false belief understanding emerge between 3 and 5 years of age. Children at this age begin to comprehend that people have a mental representation of the world, which might or might not match up with the reality (Wellman, 1990). The acquisition of the so-called epistemic mental states such as belief and knowledge (Bartsch & Wellman, 1995; Moses & Flavell, 1990) benefits children's learning in multiple ways. For example, Sabbagh and Baldwin (2001) examined the effect of knowledge state on young children's word learning. Three- and 4-year-olds were taught two novel words by a speaker who expressed either knowledge or ignorance about the words' referents. They found that both 3- and 4-year-olds learned the new word when the speaker was knowledgeable about the word, but did not learn the new word when the speaker was ignorant of the word's meaning. In contrast, only 4-year-olds were able to distinguish a knowledgeable speaker from an ignorant speaker based on experience when the speaker expressed uncertainty. Four-year-olds, but not 3-year-olds, learned the new word from the knowledgeable yet hesitant speaker.

This line of study turned out to be quite productive in showing the impact of epistemic mental states on young children's learning. Following Sabbagh and Baldwin (2001), Birch and Bloom (2002) found 4- and 5-year-olds showed sensitivity to the speakers' knowledge when learning an individual's name. Harris and associates (Clement, Koenig, & Harris, 2004; Corriveau, Pasquini, & Harris, 2005; Harris, 2007; Koenig, Clement, & Harris, 2004; Koenig & Harris, 2005) found that 4-year-olds showed advanced discrimination over 3-year-olds between a trustworthy informant and an untrustworthy informant while seeking information; they endorsed information from the trustworthy informant more often. The differentiated preference for people who have more and accurate information indicates an awareness of individual specific knowledge.

2.2 Children's Talk about Mental States and Learning

2.2.1 Desire and Belief

Children begin to talk about desire before they talk about belief. Wellman and Lagattuta (2004) reviewed children's psychological explanation of actions and suggested that belief explanation developed later than desire explanation. Older children, but not younger ones, often cited the characters' belief, knowledge, or ignorance when explaining behaviors, especially when there was a false belief. Younger children, on the other hand, used desire to explain people's actions, even anomalous actions. For example, Jimmy wanted milk on his cereal but mistakenly poured orange juice on it. Young children tended to explain the situation as Jimmy "wanted" orange juice. In fact, belief verbs such as *think* and *know* do not appear in children's talk until the third year of life

(Bretherton & Beeghly, 1982; Shatz, Wellman, & Silber, 1983). Not until the age of 4 do children precisely distinguish these verbs from each other (Johnson & Maratsos, 1977; Moore, Bryant, & Furrow, 1989; Moore & Furrow, 1991; Naigles, 2000).

Using a simulation paradigm, Papafragou, Cassidy, and Gleitman (2007) asked both adults and 3- to 5-year-olds to watch videotaped stories. At the end of each clip, the story character summarized the story using one sentence with a nonsense verb. The task was to replace the nonsense word with a real verb. They found that children, and adults to some extent, preferred an action verb over a mental verb. Even when they did use mental verbs, they chose a desire verb more often than a belief verb. When the story concerned a false belief, however, both adults and children used more belief verbs, compared to true belief stories. This study suggests that mental verbs, especially belief verbs, are a late achievement in children's verb learning.

Children's talk about their own learning reflects their understanding of the learning concept. Bartsch, Horvath, and Estes (2003) analyzed longitudinal data of natural language transcripts of five children from 2 to 7 years old, as well as their caretakers'. A total of 760 utterances concerning *teach* and *learn*, including 329 target term uses and related references by children, and 431 by adults, were analyzed. They found children talked more with their parents about what was learned, and who learned/taught than they did about when, how, and where learning occurred. Children talked about their own learning most of the time, rarely mentioning the sources of knowledge other than the teacher. Behavioral learning was mentioned more than factual learning. Sobel et al. (2007, study 1) analyzed the same data, but using only 91 utterances of children's own spontaneous utterances about teaching and learning. They found the spontaneous *learn* and *teach* utterances emerged at roughly the same time, 36 months and 41 months, respectively. Children produced equal numbers of *learn* and *teach* utterances. As rare as the spontaneous *learn* and *teach* utterances were, they did increase between the age of 3 and 5. The analysis also found children talked less about desire to learn or the relation between desires and learning as they grew older.

2.2.2 Learning and Teaching

When talking about their school experiences, children tend to use behavioral markers to describe learning. Thorpe et al. (2004) interviewed 31 children in preparatory classes and 27 in year one classes in Australia. They found children's idea of learning involved a particular set of behavioral characteristics not involving "thinking," such as "listen to the teacher," and "sit up… so you can learn more." The authors noted that "[t]hese conceptions of learning are of concern in current teaching/learning contexts where active, self-regulated construction of knowledge is advocated" (p. 111).

Pramling (1988) interviewed children from 3 to 8 years of age in Sweden. The *what* and *how* aspects of learning were examined through two questions: 1. "Tell me something you have learned;" 2. "How did you go about learning that?" The results suggested a stage theory of learning understanding. During preschool years, most children understood learning as behavioral change, i.e., *learning to do*. At this stage, the content to be learned was usually a skill, an activity, or a behavior. Only limited percentage of preschool children understood learning as representational change: *learning to know* the world. Children at this second stage began to talk about facts or knowledge as an intellectual property. Only in elementary school did children begin to appreciate learning changed the way of their thinking, i.e., *learning to understand*.

As for the question of how children think learning comes about, Pramling found at the first stage, children failed to distinguish doing from learning to do. They saw learning as the activity itself, rather than a goal of gaining new information. Later, children began to talk about learning by growing older. Finally at the third stage, children began to think learning occurred by experience or a deliberate process, either by external influence, i.e., “someone telling you,” or by personal experience. Further, the idea that knowledge was being transferred from someone to self was much more prevalent than that one could learn from personal experiences by exploring situations, settings, and engaging in activities. The latter required children to see self as a goal-directed active learner, which Pramling suggested was not present in preschool. Pramling’s study revealed that children’s concept of learning shifted from focusing on the acquisition of new behaviors to including the acquisition of new factual information during late preschool years.

A similar developmental transition was found in children’s talk about teaching. Astington and Pelletier (1996) implied that children who passed false belief task conceptualized teaching as “telling;” whereas younger children who had not achieved false belief understanding conceptualized teaching as “showing.”

The late emergence of belief verbs and children’s talking about teaching and learning in action terms suggest that children’s understanding of learning focuses on the behavioral and action aspects before they begin to appreciate that learning concerns knowledge and belief. This transition happens sometime during preschool and early elementary years.

2.3 Children's Understanding of Knowledge Source

Knowledge comes from different sources: one learns though firsthand experience, reliable testimony, or through inferential reasoning. Existing literature suggests it is a developmental process for children to learn how to keep track of the sources of their knowledge.

2.3.1 Firsthand Experience

Studies have shown that children younger than the age of 4 are yet to establish the casual link between perceptual access and knowing (Mossler, Marvin, & Greenberg, 1976; Perner & Ogden, 1988; Wimmer, Hogrefe, & Perner, 1988). Mossler et al. (1976) found that 3-year-olds failed to understand someone who did not hear a statement was ignorant in relation to someone who did, suggesting they did not understand the causal relation between hearing and knowing. A similar conclusion was reached in the case of visual perception. Wimmer et al. (1988) presented a box to pairs of children; one out of each pair had the chance to see inside of the box. Three-year-olds, and even some 4-year-olds, could not understand that their partner who had not seen the content of the box did not know what was inside. However, this phenomenon only exists in epistemic mental states. Using a similar paradigm to that in Wimmer et al.'s (1988) study, Perner and Ogden (1988) told children two parallel stories, one of which was about two children who were ignorant about the content of a box and only one of them looked inside the box; the other was about two children who were hungry and only one was allowed to eat his food. They found young children's judgment of who was hungry was better than their judgment of who knew the content of the box.

Using simplified task questions, Pratt and Bryant (1990) found 3-year-olds were able to understand those who had seen inside of a box knew the content, whereas those who had not did not know. This insight might be due to young children's implicit understanding of relation between perceptual access and knowledge, as Clements and Perner (1994) argued. Clements and Perner (1994) found when responding to a classic unexpected location transfer false belief task, 70% of their young 3-year-olds looked in anticipation to the location where the character thought an object would be, despite the fact they could not correctly answer the question verbally. Further study by Garnham and Ruffman (2001) used similar eye gaze paradigm and found that children predominately looked at the correct location without looking at a third neutral location, suggesting that the looking behavior indicated an implicit understanding of false belief, instead of a simple association.

Not only do children have trouble with the causal relation between perceptual access and knowing, they also find it challenging to remember how they came across certain knowledge (Gopnik & Graf, 1988; Pillow, 1989). Gopnik and Graf (1988) revealed new information through different channels to children from 3 to 5 years old. Children learned about the content of a closed box either through seeing the content firsthand, by being told, or through inference from a cue. Three-year-olds, but not 5-year-olds, could not remember how they learned the content of the box afterwards. Pillow (1989) found even when 3-year-olds could correctly attribute knowledge to the viewer based on perceptual access, most of them could not justify why the viewer knew the information.

Young children's difficulty with the source of their own knowledge is also shown in their confusion of the modal specificity of perception (O'Neill & Chong, 2001; O'Neill & Gopnik, 1991). For example, 3-year-olds could not realize touching an object does not provide information about its color (O'Neill & Gopnik, 1991). O'Neill and Chong (2001) further examined children's understanding of the function of the five senses in identifying the properties of an object. Again, they found 3-year-olds, but not older children, performed poorly on identifying the function of a sensory organ and locating the organ that performed a certain function.

Three-year-olds' difficulty with the source of the knowledge is related to their ToM restrictions. A study by Burr and Hofer (2002) specified a close link between children's knowledge source justification and their false belief developmental level. Young children's difficulty with source justification adds to the confusion of the relation between perceptual access and knowledge construction. Together, they suggest a developing process in establishing a coherent causal explanation of knowledge, which is in line with the well-received theory theory account of mental state understanding development (See Gopnik, Meltzoff, & Kuhl, 1999; Gopnik & Wellman, 1994).

2.3.2 Secondhand Information

Children's difficulty with representing knowledge at a mental level not only affects their learning through firsthand experience, it also affects their learning from others. Learning from others' testimony makes up a significant portion of our knowledge base (Harris, 2002; Wilson, 1983). Seeing other people as a source of knowledge, according to Flavell and Miller (1998), requires children "to be aware of the knowledge state of the other person and that such knowledge may or may not be the same as their own" (p. 82). Understanding this knowledge difference facilitates children's learning "as children would know what the starting knowledge is and how that can be used, or changed, to facilitate a solution to a particular problem" (p. 82).

As discussed before, children before the age of 3 have an implicit awareness of knowledge differences in people that allows them to learn selectively from different sources (Birch & Bloom, 2002; Sabbagh & Baldwin, 2001). However, young children do not appear to have an explicit understanding of other people as a source of knowledge. The development of such understanding shares a similar trajectory as that of perceptual experience as a source of knowledge. Gopnik and Graf (1988) showed that 3-year-olds could not remember where they learned a fact after being told by others, compared to older children. Wimmer et al. (1988) further indicated that 3-year-olds could not assign knowledge or ignorance to others when they witnessed that person being told or deprived of information.

Using an ambiguous referential task, Sodian (1988, experiment 1) showed children a toy cupboard with three drawers: a red drawer on top and two drawers on the bottom, one red and the other green. Children were then shown a story scene where one doll hid a piece of chocolate in one of the drawers and told a second doll about the location in either an informative way (in the upper drawer/green drawer), or in an ambiguous way (in the red drawer/lower drawer). The results established that 6-year-olds, but not 4-year-olds, could judge accurately the listener's knowledge when the instruction was ambiguous. The younger children tended to think the second doll knew where the chocolate was even when given an ambiguous and indecisive instruction.

Compared to verbal communication, pointing is an evolutionarily more fundamental communicative channel to exchange information. Povinelli and deBlois (1992) tested 3- and 4-year-olds' comprehension of knowledge formation through pointing. In their study, the experimenter hid a surprise under one of the four cups, and then communicated the information to children via pointing. Both 3- and 4-year-olds could correctly locate the surprise; whereas only 4-year-olds could explain how they knew where to look. Four-year-olds also showed appreciation of others' knowledge state based on perceptual access; they were able to discriminate two experimenters' pointing based on which one was present when the surprise was hidden.

2.3.3 Inference

Knowledge is not always readily available. Sometime one has to reason from accessible clues to reach a justified speculation. Inference as a knowledge source is especially difficult for children to comprehend (Miller, Hardin, & Montgomery, 2003; Sodian & Wimmer, 1987; Woolley & Bruell, 1996). Sodian and Wimmer (1987) found 4- and 5-year-olds, but not 6-year-olds, claimed an experimenter knew the color of a ball only if the experimenter saw the ball, but not when the experimenter was told the ball was from a jar full of blue balls. Children in the inference condition from Gopnik and Graf's (1988) study were shown an egg carton and told the contents of a container belonged to the egg carton. Although all the children from 3- to 5-year of age could make the inference about what was in the container, only 4- and 5-year-olds could identify the source of their knowledge. Woolley and Bruell (1996) found that 3-year-olds could report whether they had seen, been told, or imagined the content of a box with a 75% correct rate, but had difficulty differentiating inference from other sources, with a correct rate of about 50%. By directly comparing children's understanding of knowledge acquisition, Miller et al. (2003) found that among perception, communication, and inference, perception was the easiest information source for children; inference was the most difficult one.

One needs evidence to make a successful inference. The need for evidence in knowledge construction does not occur to children until elementary school years. Three- and 4-year-olds could not follow a trail of footprints to locate the person who left those prints; only about 41% of the 5-year-olds were able to do so (Dowlati & Abravanel, 2006). Ruffman, Olson, and Keenan (1993) argued that 3-year-olds were not consciously aware that leaving footprints could lead to others' false belief, even though they sometimes behaved deceptively. Astington, Pelletier and Homer (2002) found when 5-year-olds were asked for evidence for their beliefs, they often gave the cause of the event, but not their reason for believing it. Only those who had developed second-order false-belief understanding, usually school aged children, could state the evidence for the beliefs.

To summarize, children's understanding of knowledge source develops between 3 and 5 years of age, around the same time they acquire a representational ToM. To recognize perceptual access, testimony, and inference as knowledge sources, the child needs to firstly appreciate knowledge as a mental representation before she recognizes perception, testimony, and inference could causally change the mental representation and therefore alter knowledge. Since knowledge state change is the foremost feature in learning, the next section turns to the question of how children understand the knowledge state difference before and after learning.

2.4 Children's Understanding of Knowledge State Change

In the appearance-reality false belief studies, 3-year-olds could not easily report their previous false belief about the identity of a disguised object (e.g., Gopnik & Astington, 1988), even when they were reminded about their previous false belief with video clips of their own former responses (Zelazo & Boseovski, 2001). It seems often times young children learn new knowledge without the explicit awareness that learning even occurred, especially when the learning involves mental representation (Esbensen, Taylor, & Stoess, 1997; Gopnik & Slaughter, 1991; Taylor, Esbensen, & Bennett, 1994).

2.4.1 Remembering Previous Mental States

Gopnik and Slaughter (1991) compared children's understanding of the changes in various mental states. They found that even 3-year-olds were able to recall their previous mental states such as pretense and perception, as long as those mental states did not involve evaluating the relation between the mentality and the reality. Those same children found it more difficult to recall their previous desire and intention, but not as difficult as previous belief. Gopnik and Slaughter argued that the different representational processes involved in those mental states were responsible for the difference in children's performance. Understanding the changes in mental states with a world-to-mind direction of fit (Searle, 1983), such as desire, did not require a representational change in the same way as those mental states with a mind-to-world direction of fit, such as belief and knowledge.

That is especially true in the case of learning. Taylor et al. (1994) found children tended to report they had known the newly learned information for a long time. In one of the experiments, they told 4- and 5-year-olds animal stories containing a novel fact, such as the function of cats' whiskers and tigers' stripes. They found that most of the 4-year-olds, and more than half of the 5-year-olds, reported that they had known the novel fact for a "long time," instead of just learned it "today." This response pattern appeared consistently across various learning situations, including learning novel chemical reactions, using both familiar and unfamiliar objects, and learning novel color words such as chartreuse. Children's response for when the knowledge was learned was not affected by the way the task questions were framed: they consistently reported that they had "always" known the newly learned information; they knew it "yesterday;" when they were "3-year-olds;" or when they were "babies." Children's performance did improve if the learning event was explicitly labeled by the experimenter with phrases such as "I'll *teach* it to you."

Both Gopnik and Slaughter and Taylor et al. reasoned that children's difficulty in remembering their previous mental states or when learning had occurred was not due to a memory deficit. In Taylor et al., even though only 14% of the 4-year-olds remembered they had just learned a new color name, 84% of the same children could correctly report they had received a sticker for participating in the study. There was also evidence that preschool children could produce accurate and differentiated answers to questions like what happened "yesterday," "last weekend," and "last summer," and could distinguish recent event from the past (Friedman, 1991, 1992).

In order to accurately remember when learning happened and what has been learned, one needs to construct an episodic memory of the learning event and be able to distinguish the mental representational difference before and after the learning. It was suggested that the development of episodic memory (Naito, 2003; Perner, 2001) and the ability to mentally travel from one time point to another (Atance & Meltzoff, 2005; Atance & O'Neill, 2005; Busby & Suddendorf, 2005) are associated with children's ToM. Before young children develop a representational ToM, remembering what they have learned and when will remain a challenge.

2.4.2 Behavioral Learning versus Factual Learning

If the reason children fail to remember what they have learned lies in the limits in their mental representation, behavioral learning that does not involve mental representation should be easier for children to remember. Esbensen et al. (1997) demonstrated that it is in fact the case. They taught children new facts, such as grambee's (a made-up animal) food was grass; as well as new behaviors, such as how to zwib (a made-up body movement). Four-year-olds reported they learned something new more often when the novel information was behavioral than when it was factual. The advantage favoring behavioral learning remained true even when the contents of behavioral learning and factual learning were identical. For example, children in the behavioral learning condition learned how to count in Japanese; whereas children in the factual learning condition learned the Japanese counting words. Both 4- and 5-year-olds were more likely to report their behavioral learning, but 4-year-olds, and some 5-year-olds, had difficulty realizing they just learned something new when the knowledge was factual.

A recent study by Tang, Bartsch, and Nunez (2007) attempted to replicate Esbensen et al.'s result on the discrepancy between children's report on behavioral learning and factual learning with more rigorously controlled learning situations. Instead of assuming children knew a familiar fact (e.g., the color red), they taught children both the old knowledge and the new knowledge one week apart, using an explicit teaching paradigm. To control the familiarity of both the new and the old knowledge, they used artificial knowledge in both learning sections and counterbalanced them. They also asked in two different ways about when children learned the information: the temporal location question of "did you know (the new knowledge or the old knowledge) yesterday," and the temporal distance question of "which have you known longer, (the new knowledge) or (the old knowledge)." The same questions were asked about the control event of receiving stickers. Their results partially replicated the discrepancy between behavioral learning and factual learning. Using only the scores of children who answered the control questions about receiving stickers correctly, they found that 6-year-olds, but not 4-year-olds, showed an advantage in remembering behavioral learning, and children performed better on temporal distance questions than on temporal location questions. Furthermore, by subtracting the response on the temporal location question of the new knowledge from that of the old knowledge, they found 4- to 6-year-olds showed a clear advantage in discriminating between old knowledge and new knowledge in behavioral learning than in factual learning.

2.5 Epistemic Egocentrism in Children's Understanding of Knowledge Change

Children's insufficiency in understanding knowledge as a private mental property is responsible for over-attributing knowledge to naive others and themselves (Gopnik & Astington, 1988; Miller et al., 2003; Mossler et al., 1976; Perner & Ogden, 1988; Robinson, Thomas, Parton, & Nye, 1997; Sodian, 1988; Taylor, 1988; Taylor, Cartwright, & Bowden, 1991; Taylor et al., 1994; Wimmer et al., 1988; Wimmer & Perner, 1983). This phenomenon has been extensively researched under various labels such as egocentric perspective taking (Piaget & Inhelder, 1956), curse of knowledge (Birch, 2005;

Birch & Bloom, 2003 Camerer, Loewenstain, & Weber, 1989), and epistemic egocentrism (Royzman, Cassidy, & Baron, 2003). Epistemic egocentrism is not only present in children, but also an enduring phenomenon in adults' judgment and decision-making (see Royzman et al., 2003 for review).

2.5.1 Over-attributing Mental States to Naive Others

Epistemic egocentrism affects children's understanding of mentality in activities such as pretense and drawing. Although children begin to engage in pretense from the age of 2 (Leslie, 1987; Lillard & Witherington, 2004), they do not fully understand pretense involves a mental representation until the age of 5 (Harris, 1994; Lillard; 1993). In a broadly cited study by Lillard (1993), children were introduced to a character named Moe. In the story, Moe had never heard of or seen a kangaroo and therefore did not know what a kangaroo was; however, he was hopping just like a kangaroo. Children were asked whether Moe was pretending to be a kangaroo; and whether he was thinking about a kangaroo. Lillard found that 65% of the 4-year-olds insisted that Moe was pretending to be a kangaroo, even though they did recognize Moe did not know what a kangaroo was. Lillard argued that young children understood pretense as acting-as-if, without a mental representation. Later studies simplified the Moe task through modifications like giving a reason why Moe was hopping (e.g., hot paveway), and using forced choice questions (Davis, Woolley, & Bruell, 2002; Ganea, Lillard, & Turkheimer, 2004). Those modifications improved children's performance to some extent. Still, 3- and 4-year-olds often claimed somebody who resembled certain animals' appearance without knowing was pretending (Sobel, 2004).

Similar response patterns were found in children's understanding of the production of the symbolic representation in drawings (Richert & Lillard, 2002). Children were told comparable stories about drawing similar to the Moe story. Young children claimed an artist who did not know something was, yet whose drawing coincidently resembled it, was drawing it. The authors argued that 4- and 5-year-olds based their judgments on the drawings' external resemblance of the objects.

Young children tend to erroneously assign their own belief to others. In the unexpected content task (Gopnik & Astington, 1988), 3-year-olds consistently answered pencils when being asked what a naïve child would think was in a candy container after seeing pencils in it. In the unexpected location task (Wimmer & Perner, 1983), the participating children had seen the transformation of the location; whereas the story protagonist Maxi had not. Young children consistently claimed Maxi would look for the chocolate in the new location. Both the naïve child in the first story and Maxi in the second story did not have perceptual access to the real content or the true location, yet children thought they knew the truth just as they themselves did. Three- and 4-year-olds over-attributed knowledge about the content of a box to a child or a puppet who had not seen the inside of the box in the knowledge acquisition tasks (e.g., Pillow, 1999; Wimmer et al., 1988). In the partial or ambiguous information tasks (e.g., Sodian, 1988; Taylor, 1988; Taylor et al., 1991), 4-year-olds thought those who only had access to an unidentifiable portion of a picture knew what the picture was; and those who were given ambiguous and indecisive information about a hiding place knew where the communicator was indicating.

2.5.2 Over-attributing Knowledge to Previous or Future Selves

Children over-attribute knowledge to their previous or future selves too. Earlier work in metacognition suggested that people tend to be over confident in their self-assessment of knowing, learning, and remembering. Nelson (1999) described three types of prospective memory monitoring biases. The *ease-of-learning judgment* (EOL) refers to the learner's evaluation of how easy or difficult an item would be to learn. The *judgment of learning* (JOL) refers to the prediction of future recall during or right after learning. And the *feeling of knowing* (FOK) refers to rating the likelihood of future recognition of currently forgotten information. It happens when one has a tip-of-tongue feeling of knowing something but could not retrieve for the moment. Research had shown that although children showed certain monitoring sensitivity (Cultice, Somerville, & Wellman, 1983), the metacognitive ability of monitoring one's own learning and memory increased with age (Hacker, 1989; McCormick, 2003).

Mills and Keil (2004) found when children were asked to judge how well they understood the working mechanism of things like a toaster, they tended to overestimate: the younger the children, the higher their ratings. Only the 2nd graders and 4th graders, but not the kindergartners, showed awareness of their own overestimation after learning the expert's explanation. They realized they knew less than they thought, a phenomenon which the authors called *illusion of explanatory depth*. The kindergartners, on the other hand, tended to claim that they knew all of that already from the beginning after hearing the expert's explanation. Their ratings of their own understanding in fact increased after learning the expert's explanation.

Similar *I knew it all along* effect is found in children's hindsight bias (Bernstein, Atance, Meltzoff, & Loftus, 2007; Bernstein, Loftus, & Meltzoff, 2005). Bernstein and colleagues developed a set of hindsight tests for children. For example, children were shown computer-generated pictures of various degrees of degradation and asked to identify what the picture was as soon as they could, with the picture being gradually revealed step by step from the most obscure view to the clearest view. Hindsight bias was calculated using the ratio of baseline identification point (identifying the picture without knowing what it was) divided by the hindsight identification point (identifying the picture knowing what it was). Three- to 5-year-olds showed robust hindsight bias. Their performances on hindsight bias and theory of mind tasks were significantly correlated, controlling for age, language ability, and inhibitory control.

This line of research is especially significant in *mindful learning*. It is hard to imagine a person making an effort to learn if one does not know that one does not know. As Mills and Keil (2004) put it, "[l]earners may make many mistakes in determining when they have fully understood a concept… [t]hey nod their heads in agreement when the teacher asks if they understood a topic, not always just to get the teacher to be quiet, but because they often truly think they understand" (p. 27).

2.6 Children's Understanding of Knowledge and Belief in Teaching and Learning

Recent progress in studies of children's teaching indirectly informs our understanding of children's *mindful learning*. The argument is that if children are natural teachers with an understanding of the general purpose of teaching, they are more likely to engage in their own learning (Olson & Torrance, 1996; Ziv & Frye, 2004). A study by Davis-Unger and Carlson (2008) had 3.5 to 5.5 years old children teach a confederate how to play a board game. They found children's teaching skills increased significantly with age; and the number of teaching strategies used by children was correlated with their false belief understanding after controlling for age. The authors argued that using various teaching strategies indicated children understood the knowledge gap and were sensitive to the demands of learning, which might help them in realizing their own knowledge deficit and the teachers' intention during learning.

One's belief, but not the actual knowledge state, determines whether one will try to learn something or not. A person will try to learn when she believes she does not know, no matter whether or not she really knows. A person will not try to learn when she believes she knows, even though her knowledge state might be outdated or even wrong. Little research exists on the children's understanding of belief about knowledge state in learning. Ziv and Frye (2004) investigated children's concept of teaching. They found that 3-year-olds understood that the ignorant person should be taught, and the knowledgeable person should teach, even when the ignorant person was a teacher, or the knowledgeable person was a child. However, only 5-year-olds had a grasp of the role of false belief about the knowledge state in teaching. When the teacher had a false belief about his or her own or the learner's knowledge state, the older children predicted teaching would follow the teacher's beliefs; yet the younger children predicted teaching would follow the actual knowledge states. Older children, but not younger children, also answered correctly on the location false belief task. Children's performance on the teaching stories that involved teacher's false beliefs correlated with their performance on the false belief task.

2.7 Children's Understanding of Learning Intention

2.7.1 Children's Understanding of Intention

The understanding of intention is an important component in our everyday mental state reasoning. Lack of intention understanding presents great difficulty in social functioning. Autistic children could understand picture stories in mechanical or behavioral terms perfectly; however, they showed enormous difficulty in understanding the stories in intentional terms compared to normal children (Baron-Cohen, Leslie, & Frith, 1986). Autistic children also experienced more difficulty in understanding a desired outcome achieved by coincidence (Phillips, Baron-Cohen, & Rutter, 1998). Phillips et al. told both autistic and normal children a prize was hiding in some of the colored cans. Children were asked to pick a can to shoot in order to get a prize. Autistic children, as well as young normal children, tended to alter their previous intention when they missed the intended colored can. They reported after the shooting that they did not mean to shoot the can they picked before; instead, they meant to shoot the can they actually shot down, especially when that can contained a prize.

The understanding of intention is correlated to false belief understanding (e.g., Lang & Perner, 2002, Phillips et al., 1998; Russell, Hill, & Franco, 2001). Young children who are yet to achieve false belief understanding find it difficult to differentiate similar actions with or without an intention, or with different intentions. For example, young children failed to recognize certain bodily functions such as knee-jerk reaction and sneezing were unintentional (Lang & Perner, 2002; Montgomery & Lightner, 2004), neither was passive body movement such as drawing a picture with eyes shut and other people holding your hand (Montgomery & Lightner, 2004). When naming a pictorial representation, 3- and 4-year-olds could use the creator's intention to name ambiguous representations (Bloom & Markson, 1998; Brown & Woolley, 2001; Gelman & Bloom, 2000). But when the intention was in direct conflict with the physical appearance, children rejected the intention-based name (Brown & Woolley, 2001). Not only did young children think of simple actions without intention to pretend as pretense (Lillard, 1993, 1998; Sobel, 2004, 2007, experiment 1), they treated mistakes and pretences just the same as lies, disregarding the different underlying intentions (Berthoud-Papandropoulou & Kilcher, 2003; Siegal & Peterson, 1998; Taylor, Lussier, & Maring, 2003). When judging how serious an action was in violating moral values, younger children depended on the consequences of the action; older children, on the other hand, depended on the intention of the action (Chandler, Sokel, & Hallett, 2001).

Young children's faulty report of their own previous intention represents their insufficient intention understanding. In Phillips et al.'s (1998) study, even though the typical children's over-attribution of intention was not as significant as the autistic children's, the normal 4-year-olds, but not the 5-year-olds, had difficulty reporting their previous intention in cases of failed goal (when they shot down the can they picked but it turned out containing no prize).

Russell et al. (2001) developed a transparent intention task to examine children's report of their previous intention. They showed children a partial picture on a transparency film of a boy missing an ear, and asked children to add the ear in the picture. In the false-belief condition, after the children drew the ear, it was revealed that on top of the boy transparency, there was in fact another film with a cup missing a handle, previously masked by the boy picture. The children's line drawing of the ear turned out to be the cup handle on the top film. In the true-belief condition, the children were firstly shown only one single transparency, the cup. After they finished drawing the cup handle, it was demonstrated how a second transparency of a boy could be placed under the first one, and their previous drawing turned out to fit the second picture perfectly as an ear. Children were asked what they initially intended to draw. The results showed that 3- and 4-year-olds, both in the true belief condition and in the false belief condition, had trouble reporting their initial intention. Furthermore, the results stayed the same when the participant observed the process as a third person.

The studies in children's understanding of intention suggest that young children understand intention is the cause of action. However, when there is a conflict between the intention and the outcome, young children often focus on the outcome. Children's understanding of intention and false belief understanding develop over the same time period.

2.7.2 Children's Understanding of Learning Intention

Understanding of the role of intention in learning may help mindful learners to appreciate the motivational mental states, which could eventually allow them to modify their own mental effort in learning. A mindful learner needs to recognize that learning intention leads to a learning behavior, which brings about the learning outcome; and more importantly, learning intention and learning outcome are not always congruent with each other. There are scenarios when a person tries to learn but fails, or when a person does not try to learn but ends up learning through accidental discovery or implicit learning. Children need to understand how to make the learning intention judgment independent of the learning outcome.

A recent study by Sobel et al. (2007, study 2) made an initial effort in understanding children's concept of learning in relation to motivational mental states such as desire, attention, and intention. In the study, 4- and 6-year-olds were shown pictures of a teacher and several children. Stories were told about each child's mental states in the event of learning a song from the teacher, including desire, attention, and intention. A combination of two of the mental states were mentioned in each story, that were either consistent or in conflict with each other. Children were asked whether the character learned the song and why.

Both age groups performed well on the consistent stories. They judged the character learned the song if s/he showed positive motivational mental states or did not learn the song otherwise, which suggested even at the age of 4, children understood motivational mental states such as desire, intention, and attention had a casual effect on learning. There was age difference in one of the consistent stories though. When the character did not intend to learn, or pay attention, 4-year-olds were more likely than 6-year-olds to judge the character learned. It seemed that young children had trouble understanding the absence of motivation might lead to failed learning.

Children's performances in the inconsistent stories were not different from chance level. Still, 4-year-olds judged the character who wanted to learn but did not practice learned the song more often than chance; 6-year-olds judged the character who wanted to learn but did not attend to the song learned less often than chance. The authors argued that 4-year-olds tended to judge whether someone learned based on desire, whereas 6-year-olds were more likely to integrate desire, intention, and attention together.

There is, however, one aspect of Sobel et al.'s study that may raise questions about the significance of the results. By posting the task question in an open-ended manner ("Did the person learn how to sing the song?"), the design of the study assumes a casual relationship between the motivational mental states and the learning outcome. This is not always the case. As discussed before, learning does not have to be intentional. Even intentional learning does not necessarily bring out the intended outcome. In other words, the design of the study implicitly characterizes the concept of learning as a direct outcome of motivation instead of representational knowledge change. The consequence of such a distorted definition of learning is especially serious in the inconsistent stories. The answer to the question of whether the character learned the song in those stories is rather arbitrary. It is equally possible for one to learn a song or fail to do so in the inconsistent stories. Children's chance level performance is the empirical evidence of such an argument. Because of the questionable design of the study, the results may be less informative in terms of understanding what children think of the effect of motivational mental states on learning.

Another study on children's understanding of teaching as an intentional activity sheds lights on children's concept of learning indirectly (Frye & Ziv, 2005). Different from learning, which can be intentional or unintentional, teaching is "an intentional activity to increase the knowledge (or understanding) of another, thereby reducing the knowledge difference between teacher and learner" (Ziv & Frye, 2004, p. 458). Frye and Ziv (2005) examined 3- and 5-year-olds' understanding of intention in teaching. They told children stories about either a teaching event, or an event where the teacher was not aware of the presence of the learner, hence an imitation event. They found that 3-year-olds tended to say the teacher tried to teach even without knowing the learner was there. Only 5-year-olds could distinguish the teaching intention from the learning intention in the imitation. They also found 3-year-olds had trouble detecting a teaching intention embedded in a game. It seems at least in the case of teaching, young children found it difficult to understand an intention that is not explicitly stated, or in conflict with the outcome.

CHAPTER THREE

Present Study

3.1 Research Questions

ToM research has revealed qualitative changes in preschoolers' understanding of knowledge acquisition. Despite the broad application of these findings, they are yet to be applied to children's understanding of learning in educational settings. *Mindful learning* theorizes that children's concept of learning is shaped by their comprehension of both epistemological mental states and motivational mental states. Children become mindful learners when they understand knowledge state change, belief about the knowledge state, and learning intentions. It is hypothesized that young children start with a concept of learning at the behavioral level. During the preschool and early elementary years, children develop a new appreciation of learning as a mental process, together with the achievement of ToM understanding.

The goal of the present study is to examine children's comprehension of the concept of learning in a ToM framework. The study is aimed to pinpoint the mental properties that are essential to children's understanding of learning, and outline the developmental trajectory of *mindful learning* during preschool years. The relation between *mindful learning* and the general ToM developmental level, including the false belief understanding is also examined.

To be specific, the research investigates:

1. When do children understand learning as a mental representational change, and knowledge as a stable outcome of that change?

2. Can children differentiate learning from mere actions that resemble learning but without the mental representation?
3. Do children's own knowledge states affect their differentiation between action and learning, and how?
4. Do they recognize people's beliefs about their knowledge states affect their learning intention?
5. Do children understand that intention plays an important role in learning yet it is neither a sufficient nor a necessary condition for learning?
6. How does the developing ToM affect children's understanding of the concept of learning?
7. Are there any culturally specific characteristics in both children's *mindful learning* and ToM development?

3.2 Outline of the Six Studies

The present research explores children's developing concept of *mindful learning* in six studies. They focus on children's understanding of knowledge state change, children's understanding of beliefs about knowledge state, and children's understanding of learning intentions. The first three studies address the issue of knowledge change. In Study 1, participants were asked to judge whether the character had learned in the story, based on the comparison of knowledge state before and after a learning event. A prediction question followed the learning question to examine participants' understanding of learning as enduring mental state change. Participants were asked based on the learning outcome, whether the character needed to learn the same knowledge in the future. Study 2 further explores participants' understanding of genuine knowledge change. An apparent conflict between the character's action and knowledge state was introduced. For example, the character could draw a circle that perfectly resembles a letter *O*, yet had no mental representation of a letter *O* whatsoever. Participants again needed to make a judgment whether the character had learned how to write a letter *O* or not, and whether the character needed to learn the same knowledge in the future. Study 3 adapted the tasks in Study 2 and further examined the effect of familiarity with learning content on participants' learning judgment. Forced choice question format was adopted to enable children to directly compare genuine learning with an action without knowledge change, both in familiar and unfamiliar learning contexts.

Study 4 and Study 5 examine children's understanding of belief about the knowledge state in learning. In Study 4, participants heard stories about a character who either had a true or a false belief about one's own knowledge state. Questions were asked about whether the character needed to learn based on her knowledge state (the *Necessity* question), and whether the character would try to learn based on her belief (the *Intention* question). When the character held a true belief, the answers to the *Necessity* question and the *Intention* question would be to the same; when the character held a false belief about knowledge state, however, the answers to the two questions would be different. Participants needed to understand that learning intention follows belief instead of the actual knowledge state to correctly answer the questions. Study 5 further investigated the belief-intention relation but situated the learning contents in broader contexts to include common sense knowledge, obvious knowledge about self, and the knowledge of location or identity in the classic false belief tasks. Study 5 also extended the knowledge state to include true belief, false belief, and ignorance. By comparing two characters with different knowledge states and beliefs in forced choice questions, Study 5 sought to reveal whether children realized both the ignorant one and the one who had a false belief needed to learn, but only the ignorant one would try to learn.

Study 6 examines children’s understanding of learning intentions. Tasks were designed so that different levels of learning intention were accompanied with a successful or failed learning outcome. The character either had a positive learning intention (try to learn), a negative learning intention (does not try to learn), or an intention of resistance (try not to learn). Participants were asked whether the character tried to learn in the story, and whether s/he learned in the end. Instead of defining learning as a direct outcome of motivational mental states and asking children to make a judgment about learning based on desire, intention, and/or attention as in Sobel et al.’s (2007) study, Study 6 acknowledges learning concerns both the learning outcome and the learning process. On the one hand, learning intention is a facilitating factor in knowledge change. On the other hand, learning is a change in the knowledge state that occurs with or without a learning intention. Even though sometimes the learning intention is consistent with the learning outcome, it is neither a sufficient nor a necessary condition for knowledge change.

3.3 ToM Measure

In each of the six studies, children’s ToM development was measured using Wellman and Liu’s (2004) ToM battery (see Appendix A). For the purpose of this study, permission to use the measure was obtained from the first author. Wellman and Liu (2004) argue that children from different social, cultural, and linguistic backgrounds develop mental state understanding following roughly the same trajectory. Information from Wellman and Liu's (2004) ToM battery would provide insight into the participants' relative standing in theory of mind development, compared to Wellman and colleagues' samples (Peterson et al., 2005; Wellman & Liu, 2004; Wellman et al., 2006). The tasks and instructions of the battery were translated into Chinese by the author of the present study and then back translated into English by another independent bilingual researcher. Discrepancies were resolved through discussion. The Chinese translation retains the integrity of the test. The two versions are linguistically comparable and consistent.

The instructions, props, and procedures used in this study were as close as possible to those used in Wellman and Liu’s, with a couple of minor exceptions. One modification in the present study was that instead of showing a drawing of the back of a head, the back of a boy figurine was shown when training children to imagine people’s facial expression in the *Hidden Emotion* task. Another modification in the materials concerned replacing garage with a house in the *Diverse Belief* task, since car garage is not a popular residential structure in China as that in the United States. Wellman and Liu suggested two orders of administrating the tasks in the scale: the first of which is *Diverse Desire, Knowledge Access, Contents False Belief, Diverse Belief, Explicit False Belief,* and *Hidden Emotion*; the second is *Diverse Desire, Explicit False Belief, Diverse Belief, Contents False Belief, Knowledge Access,* and *Hidden Emotion*. In the present study, about half of the children were given the measure using the first order; the other half using the second order.

CHAPTER FOUR

Study 1: Knowledge Change

4.1 Design

Study 1 is aimed to find out whether preschool children understand knowledge change is a necessary condition for learning. Three types of learning stories, including *Successful Learning* (SL), *Failed Learning* (FL), and *Previous Learning* (PL), involved a character whose knowledge state either changed because of the learning event, or stayed the same. Control questions about the characters' knowledge states were asked both before and after the learning event. Two test questions addressed whether the character learned the content (the Learning question); and whether the character needed to learn the same content in future event (the Prediction question).

A child with a working concept of learning should recognize the character learned if the knowledge state changed from not knowing to knowing; the character did not learn if the knowledge state remained the same. If the child understands knowledge change is an enduring mental state change instead of a momentary behavioral change, s/he should be able to infer that the same knowledge could be applied in a future event. In other words, one does not need to learn what one already knows. The desire to learn was established in the prediction question (e.g., s/he wants to perform the task) to focus child's attention on the knowledge change.

Table 4.1 outlined the task specifications of Study 1. In SL, the learner's knowledge state shifted from the pre-event negative status to post-event positive status; in FL, the learner's knowledge state stayed negative even after the learning event; and in PL, the learner had a positive knowledge state before the current learning event occurred. A sample PL story reads like this:

> Do you know how to write the letter C? Can you write a letter C for me?
>
> This is Even. Evan can write a letter C. He learned that a long time ago. He writes like this: C.
>
> Can Evan write a letter C?
>
> Teletubby can write a letter C. Today in school Evan watches Teletubby writing a letter C. Teletubby writes like this: C. Then Teletubby asks Evan: "Can you write a letter C?" Even says: "Yes, I can." Evan can write a letter C. He writes like this: C.
>
> Can Evan write a letter C?
>
> Did Evan learn how to write a letter C today, or did he learn that a long time ago?
>
> When Evan goes home after school, he wants write a letter C. Does he need to learn how to write a letter C?

Table 4.1

Task specifications of Study 1

Story	Pre-event knowledge state	Post-event knowledge state	Did the person learn?	Would the person need to learn?
SL	-	+	Yes	No
FL	-	-	No	Yes
PL	+	+	No	No

In each of the three learning stories, the learner was given a task from an individual content domain such as math, geometry, or literacy. To block the potential effect of the content domain, a Latin Square design was adopted to evenly distribute the content domains across different types of learning tasks (see Table 4.2). Consequently, each participant heard three stories, with each story presenting a learning task from a different domain. For each of the three learning stories, the learning content involved all three domains, with one third of the participants being told the story in each domain. Appendix B is an example of one of the three possible versions of the stories.

Table 4.2

Latin Square design of Study 1

Proportion of Participants	SL	FL	PL
1/3	Geometry	Math	Literacy
1/3	Math	Literacy	Geometry
1/3	Literacy	Geometry	Math

4.2 Participants

Children participants were recruited from a university-affiliated preschool and a non-university affiliated primary school in Chong Qing (abbreviated as CQ below) of China. Seventy-two children from 50 months to 92 months of age participated in Study 1 (M = 67.15, SD = 11.21), including 32 girls and 40 boys. There were 24 4-year-olds from 50 to 61 months (M = 55.29, SD = 3.16), including 13 girls and 11 boys; 24 5-year-olds from 61 to 71 months (M = 66.13, SD = 3.65), including 9 girls and 15 boys; and 24 6 years and older children from 72 to 92 months (M = 80.04, SD = 6.58), including 10 girls and 14 boys. Informed consents were obtained from parents.

4.3 Materials

Props were used to tell the learning stories. They included 3 to 4 pieces of blank paper of 2.5” by 2.5” in size, a pencil, figurines of boys or girls (Lego® people purchased from www.lego.com, about 2”to 2.5” in height with movable arms and legs) and a plastic doll of a Teletubby, the British cartoon character that children are familiar with in China. Wooden sticks were used for the story involving counting.

4.4 Procedures

All tasks were administrated in Mandarin. A female experimenter met children individually in a quiet room in his or her school. At the beginning of the session, the experimenter told the participant: "If it is ok with you, I'm going to tell you some stories. I need you to listen really carefully to the stories, because I'm going to ask you some questions about them afterwards."

The ToM battery was administrated according to Wellman and Liu's (2004) instructions (see Appendix A). Even though the final version of the battery has 5 tasks, the authors suggest the sixth task as optional. All 6 tasks were used throughout the present study. About half of children were given the test using the first order the authors suggested; the other half the second order.

The learning tasks started by asking the child to perform the task of interest. The child was given a piece of paper to draw or write on. For the counting story, the child was asked to count 3 sticks orally. In case the child could not perform the task, the experimenter showed the child how to do it and said: "Is this how you…(e.g., draw a square)?" Then the characters were introduced to the child. The child was shown a small figurine of a boy or a girl and Teletubby side by side. The stories were told with a demonstration of the characters' knowledge states.

For example, the experimenter started by writing down the content for the character in the PL story on a piece of paper placed near the figurine; or pointing to the paper while waving index finger indicating the character did not know how to do something in SL and FL stories. The experimenter then placed a second piece of paper next to Teletubby and wrote down the content for Teletubby. For the learning outcome, a third piece of paper was placed next to the character, below the first piece of paper, and the experimenter wrote down the content for the character, or in the case of FL, pointed to the blank paper and waved index finger, indicating the character still did not know. If the learning content involved counting, instead of writing down the content, the experimenter placed sticks in front of the character one by one while counting orally. Whenever the story characters or Teletubby spoke, the experimenter pointed to the corresponding figurine.

The control questions included a pre-event and a post-event knowledge state question. If the child could not answer the control questions correctly, the experimenter retold the story until the child got them right. For the prediction question, the experimenter moved the character away to the far end of the table, indicating the character had changed a location (e.g., from school to home). In case the child did not answer a question, the experimenter repeated the question, and then added “Yes, or no.” The order of *Yes* and *No* was counterbalanced when the child needed the cue more than once. If the question involved a choice between two options (e.g., did s/he learn this today, or did s/he learn this a long time ago), they were also counterbalanced. The experimenter never pointed to any paper when asking questions.

Three tasks in Study 1 together with two tasks from Study 2 were presented in random order. Each child finished the ToM battery and the learning tasks in random order in one session of about 15 minutes.

4.5 Results

Four children answered at least one of the control questions about previous and/or post knowledge states incorrectly. Their responses on that specific story were excluded from analyses. There were no significant differences between boys' and girls' performances on both the learning and prediction questions.

4.5.1 Learning

Figure 4.1 shows the percentage of correct responses by age for the Learning questions in Study 1. Out of the three Learning questions, only children's performance on PL-Learning increased significantly with age, $\chi^2(2, N = 71) = 9.25$, $p = .010$. Four-year-olds gave random answer to PL-Learning, binominal test's $p = .540$, $n = 24$, which is consistent with Taylor et al.'s (1994) findings, suggesting children did not differentiate learning that happened just now from learning happened some time ago. There were no statistically significant age differences in SL-Learning, $\chi^2(2, N = 71) = 4.16$, $p = .125$, since almost all children answered the question correctly. The developmental trend of FL-Learning was less straightforward without significant age difference, $\chi^2(2, N = 70) = 2.28$, $p = .320$.

SL-Learning was the easiest task among the three. About 92% of all children passed the task, compared to 69% for FL-Learning, and 75% for PL-Learning. Overall, children's performance on SL-Learning was better than FL-Learning, due to small *n* in crosstabulation cells, exact $p = .002$, $N = 69$. The performance on SL-Learning was also better than PL-Learning, exact $p = .004$, $N = 70$. No statistically significant difference was found between FL-Learning and PL-Learning, exact $p = .541$, $N = 69$. Children knew that moving from not knowing to knowing was learning, but they were less able to judge events in which the knowledge states stayed the same were not learning.

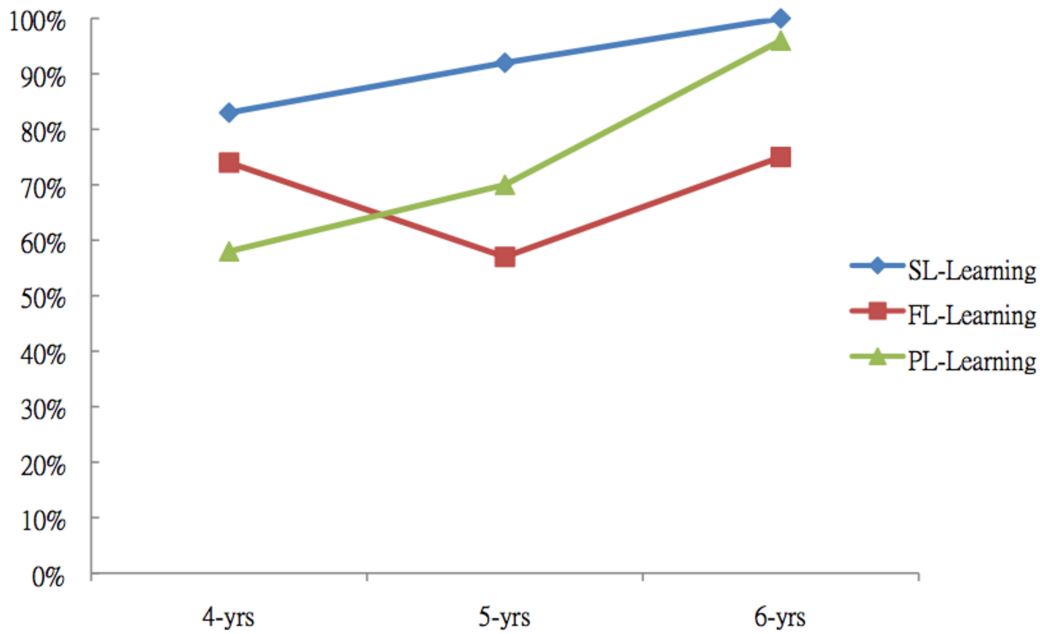

Figure 4.1. Percentage of correct responses by age for Learning questions in Study 1.

4.5.2 Prediction

Figure 4.2 demonstrates the percentages of correct responses by age for prediction questions. The SL-Prediction and FL-Prediction were coded twice: firstly based on the task; and then adjusted based on the child's answer to the Learning questions in the same tasks (abbreviated as SL-Prediction-ad and FL-Prediction-ad). For example, the correct answer to the Prediction question in FL should be: "Yes, the person needs to learn." Yet if the child answered the previous Learning question incorrectly, that is, if the child wrongly thought the character did learn in FL, the reasonable answer to the prediction question should be: "No, the person does not need to learn."

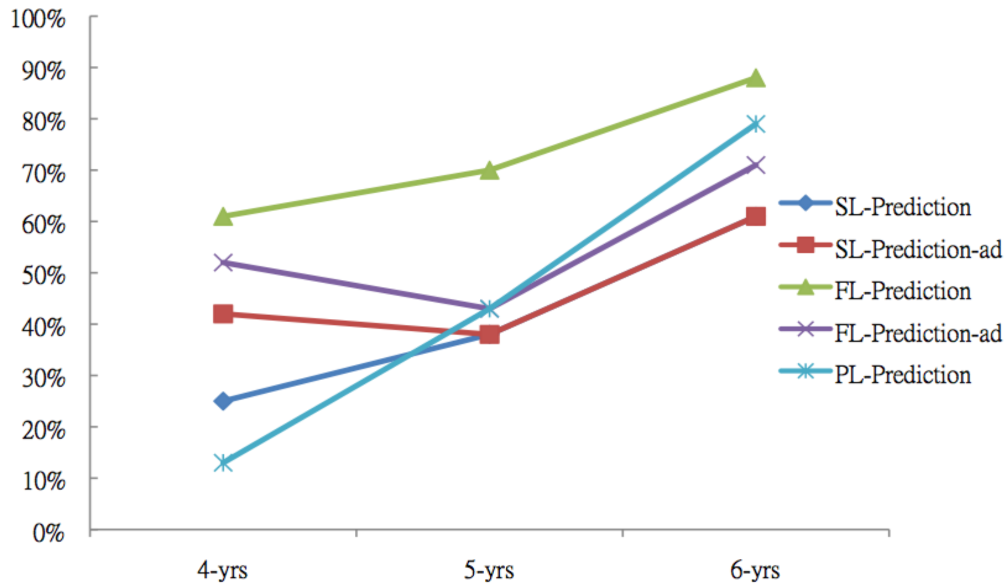

Figure 4.2. Percentage of correct responses by age for Prediction questions in Study 1.

Children's performances on prediction questions generally increased with age. But only performance on PL-Prediction showed statistically significant age difference, $\chi^2(2, N = 71) = 21.27, p < .000$. Across three age groups, children did better on FL-Prediction than SL-Prediction, $\chi^2(1, N = 69) = 9.76, p = .002$, or PL-Prediction, $\chi^2(1, N = 69) = 9.03, p = .003$. Note that the correct answer for the FL-Prediction is: "Yes, the character needs to learn;" whereas the correct answers for the SL-Prediction and PL-Prediction are: "No, the character does not need to learn." It seems children tended to answer all the prediction questions with *Yes*.

4.5.3 Relation between Learning and Prediction

Children's performance on SL-Learning was significantly better than SL-Prediction, $\chi^2(1, N = 71) = 32.24, p < .000$; also better than SL-Prediction-ad, $\chi^2(1, N = 71) = 22.88, p < .000$. The same was true between PL-Learning and PL-Prediction, $\chi^2(1, N = 69) = 9.03, p = .003$. FL-Learning was not significantly better than FL-Prediction, χ

^{2}(1, N = 70) = .13, p =.719, nor than FL-Prediction-ad, exact test's p =.064, N = 70. Overall, children answered the Learning questions better than the Prediction questions. The gaps between children's response to the Learning questions and the Prediction questions decrease with age. Take PL as an example, 58% of the 4-year-olds answered the Learning question correctly; only 13% of the same group of children answered the Prediction question correctly. The difference between the two questions was 45%. The same gap for 6-year-olds decreased to 96% - 79% = 17%.

4.6 Discussion

Children knew that moving from not knowing to knowing was learning, but they also tended to believe that events where the knowledge states stayed the same were learning too. Children's less than perfect performances on FL-Learning and PL-Learning confirmed Sobel et al.'s (2007) observation that young children over-attribute learning. It seemed that children equated learning with doing, instead of a change in the knowledge state. There is also a possibility that children might be subject to a *Yes* bias, that is, they were prone to answer all the *Yes or No* questions with *Yes.* However, the fact that the PL-Learning question with forced choice question format did not gain much advantage over FL-Learning suggests otherwise.

Children were prone to give positive responses to the Prediction questions. They did better on FL-P than on SL-P or PL-P. Their scores in the Prediction questions were generally poorer than that on the Learning questions; and the gap decreased with age. This result makes sense since the learning outcome was physically presented on a piece of paper in the tasks. Prediction, however, was based on the child's mental operations.

The result suggests that mental representational tasks were especially difficult for younger children.

There are two possible explanations to the *Yes* bias in prediction questions: the first is it actually fits the hypothesis that children equate learning with doing. If learning did *not* involve the mental representational change, every time one does something, it is "learning" all over again. An alternative explanation has to do with the ways the questions were proposed. If it is true that children tended to say *Yes* to all *Yes or No* questions, it could be an artifact of the question format. The results appear to rule out the sole effect of a questioning artifact for two reasons. First, once the SL-Prediction and FL-Prediction were adjusted, the differences between FL-Prediction-ad and SL-Prediction-ad (exact $p = .383$, $N = 69$), as well as the one between FL-Prediction-ad and PL-Prediction ($\chi^2(1, N = 69) = 1.09$, $p = .296$) disappeared. The patterns of SL-Prediction-ad and FL-Prediction-ad were similar in Figure 4.2, almost parallel to each other with much smaller distance in between. Children did not simply answer all the questions with *Yes*, rather, they showed a consistent pattern answering the prediction questions in relation to the learning questions.

Second, 13% of the 4-year-olds were correct on the PL-Prediction, and 25% were correct on SL-Prediction, which leaves 87% and 75% of whom answered those questions with *Yes*. These numbers were higher than the same children's *Yes* answer to FL-Prediction, which was 61%, even though the difference was not statistically significant, $\chi^2(2, n = 23) = 4.50$, $p = .105$. If the answers were solely determined by the question format, the percentage of the *Yes* answers to the three prediction questions should be similar. The difference suggested otherwise. Further, if children had some understanding of the knowledge state change in learning, the pattern of their answers should be the other way around, that is, the FL-Prediction should have the highest percentage in *Yes* answer just like the oldest group. The opposite pattern presented now in 4-year-olds' answers suggested that younger children were following the “hint” of the story when answering the Prediction questions: when the story stated the character learned, they tended to predict that the same person needed to learn in future event, and vice versa. This is a reasonable prediction for children who do not understand learning as a knowledge state change. If learning is just an action without representational change, it is only sensible to predict a person who did this before would do it again.

To summarize, Study 1 suggested that children had a behavioral understanding of learning. They tended to ignore knowledge state change when making a judgment whether one learned or not. Children also tended to believe one always needed to learn, regardless of one's knowledge state. Younger children seemed to follow a behavioral hint and predicted a person who learned before would need to learn the same content again in the future.

CHAPTER FIVE

Study 2: Genuine Knowledge Change

In philosopher John Searle's thought experiment of the *Chinese Room* (1980, 1984), a person who knows nothing about the Chinese language stays in a room with super computers that can give reasonable replies to questions written in Chinese. From outside the room, people will see questions in Chinese being slipped into the room and correct answers also in Chinese being slipped out, as if the person in the room is capable of having a normal conversation in Chinese. However, as Searle argued, knowledge has semantic contents. Simply being able to manipulate symbols without the semantics does not constitute knowledge. The same is true for the concept of learning. Learning occurs only when knowledge as a mental state changes. Learning does not happen when the physical consequence of an action resembles a learning outcome, but without the representational change.

5.1 Design

Do children understand the necessity of representational change in learning? Can they differentiate physical resemblance from genuine knowledge change? Study 2 was designed to understand children's comprehension of genuine knowledge change in learning. There were two tasks in Study 2, representing learning scenarios with or without a genuine knowledge change (see Appendix C for examples). In the *Discovery* task, the learner gained knowledge by discovering the representational meaning of a symbol. In the *Coincidence* task, even though the learner happened to perform the action related to knowledge representation, s/he did not attain the representational meaning of the symbol and therefore did not achieve genuine knowledge change.

Before the learning event, the child was asked whether the character had the knowledge. After the learning event, the child was again asked whether the character performed the action that lead to an outcome that perfectly resembled a representational symbol; and whether the character knew the representational meaning of the symbol. Two task questions were asked at the end of the stories, including a Learning question and a Prediction question, the same as those in Study 1. A sample *Coincidence* task reads like this:

> Do you know how to write the letter O? Can you write a letter O for me?
>
> This is Grace. Grace cannot write the letter O. She just can't.
>
> Can Grace write the letter O?
>
> Today in school, Grace draws a circle. It looks just like the letter O. Teletubby sees it and says to Grace: "That's a nice circle. You just drew a nice circle." Only Grace does not know that’s how you write the letter O.
>
> Did Grace draw a circle that looks just like the letter O?
>
> Did Grace know that’s how you write the letter O?
>
> Did Grace learn how to write the letter O today?
>
> When Grace goes home after school, she wants to write a letter O. Does she need to learn how to write the letter O?

In the contrasting *Discovery* story, Teletubby tells the character the circle is exactly how one writes a letter *O*, and that s/he just wrote a letter *O*. Children who understand learning indicates a representational change in the mind should acknowledge that learning occurred in the *Discovery* task, but not in *Coincidence* task. Table 5.1 summarizes the task specifications of Study 2.

Again, the content domains of the two tasks were counterbalanced. Half of the participants heard the *Discovery* story in a math context; and the *Coincidence* story in a literacy context. The other half heard the stories in the opposite domains. When presenting the tasks in Chinese, the literacy stories were adapted to use Chinese characters. For example, instead of a circle that looks like a letter *O*, the participants were asked to write a Chinese character for “mouth,” which has a shape of a square.

Table 5.1

Task specifications of Study 2

Story	Pre-event knowledge state	Post-event knowledge state	Did the person learn?	Would the person need to learn?
Coincidence	-	-	No	Yes
Discovery	-	+	Yes	No

5.2 Participants

Participants were the same from Study 1.

5.3 Materials and Procedures

The materials and procedures in Study 2 were similar to that in Study 1. Learning tasks from Study 1 and Study 2 were administered together in random order. Participants finished five learning tasks together with the ToM battery in one session of about 15 minutes.

5.4 Results

There were no significant differences between girls’ and boys’ responses.

5.4.1 Knowledge

Pilot testing had shown that children had trouble with the question whether the character knew the representational meaning of the symbol, even though it was asked right after the information was given explicitly in the stories. This question hence became a measure of children’s understanding of the knowledge state.

The percentage of correct responses to the *Coincidence*-Knowledge (C-Knowledge) question and the *Discovery*-Knowledge (D-Knowledge) question are shown in Figure 5.1. The total percentages of children who got the two questions right were similar, 72% and 75%, respectively. The percentage for both C-Knowledge and D-Knowledge changed significantly with age, $\chi^2(2, N = 72) = 14.88, p = .001$ for C-Knowledge, and $\chi^2(2, N = 72) = 8.33, p = .016$ for D-Knowledge. However, the directions of the changes were totally opposite to each other. With the increase of age, more and more children answered the C-Knowledge correctly, but fewer and fewer children answered the D-Knowledge correctly. The two lines in Figure 5.1 form an almost symmetric scissors-shaped pattern.

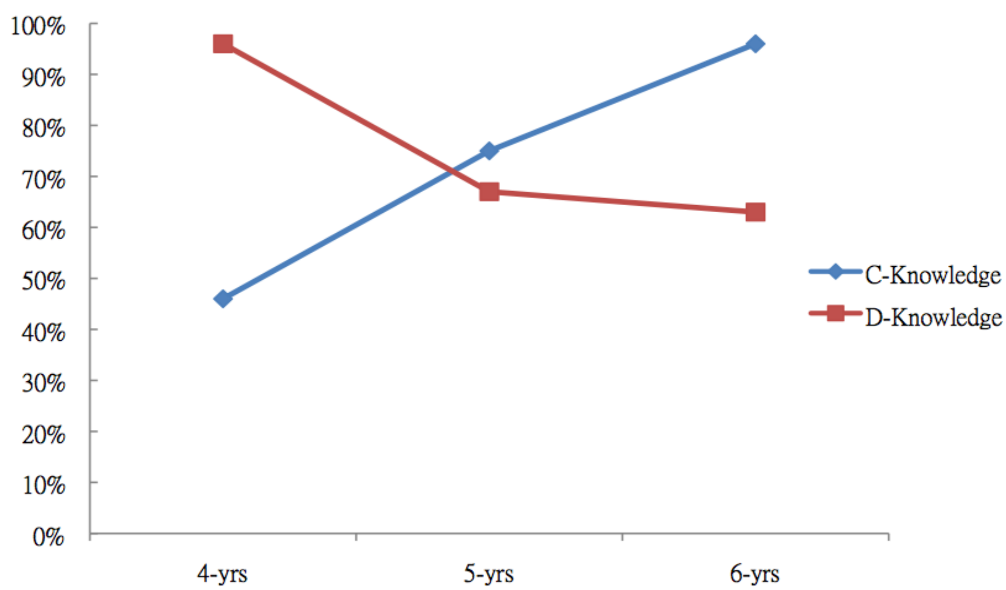

Figure 5.1. Percentage of correct responses by age for Knowledge questions in Study 2.

Younger children tended to treat action as knowledge, and give positive answers to both questions, which was the correct answer for D-Knowledge, but wrong answer for C-Knowledge. The change in C-Knowledge indicated that younger children were distracted by the action outcome; they thought drawing a circle meant one knew how to write a letter *O*. With the increase of age, more and more children realized the knowledge was more than just being able to do something. By 6 years of age, children were quite good in judging knowledge state independent of the action outcome. Older children's response pattern is puzzling. They probably thought both of the knowledge questions were asking about the characters' initial knowledge states. There are two pieces of evidence supporting this presumption. First, as shown in Table 5.2, there were no children answered both questions incorrectly, which means no children answered C-Knowledge with *Yes* and the D-Knowledge with *No*. Unless they got both questions correct, younger children were most likely to answer both questions with *Yes*; whilst older children were most likely to answer both questions with *No*. Combining the 3 age groups together, the two variables were significantly associated with each other, $\chi^2(1, N = 72) = 9.23$, $p = .002$, with significant negative correlation, *phi*(72) = -.358, $p = .002$.

Evidence from adults' data suggested similar tendency. The same two tasks in Study 2 were given to 29 Chinese college students from the same city where the children participants were recruited and 25 American college students from an east coast university. About 24% of the Chinese adults and 50% of the American adults answered D-Knowledge correct, even lower than the 6-year-olds. When being asked to explain their answers, adults indicated that they thought the questions were asking about the initial knowledge states of the characters in both stories. But if the questions ask the participants to specify the characters' knowledge states both *"at the beginning of the story"* and "*at the end of the story,"* all of the same 25 American adults answered the D-Knowledge question correctly.

Table 5.2

Crosstabulation of D-Knowledge and C-Knowledge by age in Study 2

			D-Knowledge		
Age			0	1	Total
4	C-Knowledge	0	0	13	13
		1	1	10	11
		Total	1	23	24
5	C-Knowledge	0	0	6	6
		1	8	10	18
		Total	8	16	24
6	C-Knowledge	0	0	1	1
		1	9	14	23
		Total	9	15	24
Total	C-Knowledge	0	0	20	20
		1	18	34	52
		Total	18	54	72

Note. Numbers are counts.

5.4.2 Learning

Figure 5.2 shows the percentage of correct responses on *Coincidence*-Learning (C-Learning) and *Discovery*-Learning (D-Learning). Between the two stories, children overwhelmingly answered D-Learning correctly but C-Learning incorrectly. The difference between children's performances on the two questions was significant, $\chi^2(1, N = 72) = 39.45$, $p < .000$. There were no significant age differences in the two questions,

$\chi^2(2, N = 72) = 2.19, p = .335$ for C-Learning; $\chi^2(2, N = 72) = .52, p = .770$ for D-Learning. Even the oldest children in the current sample found C-Learning extremely difficult, with only one third of them got the question correct. Children regarded behavioral change as learning, regardless of whether the behavioral change involves a mental representational change.

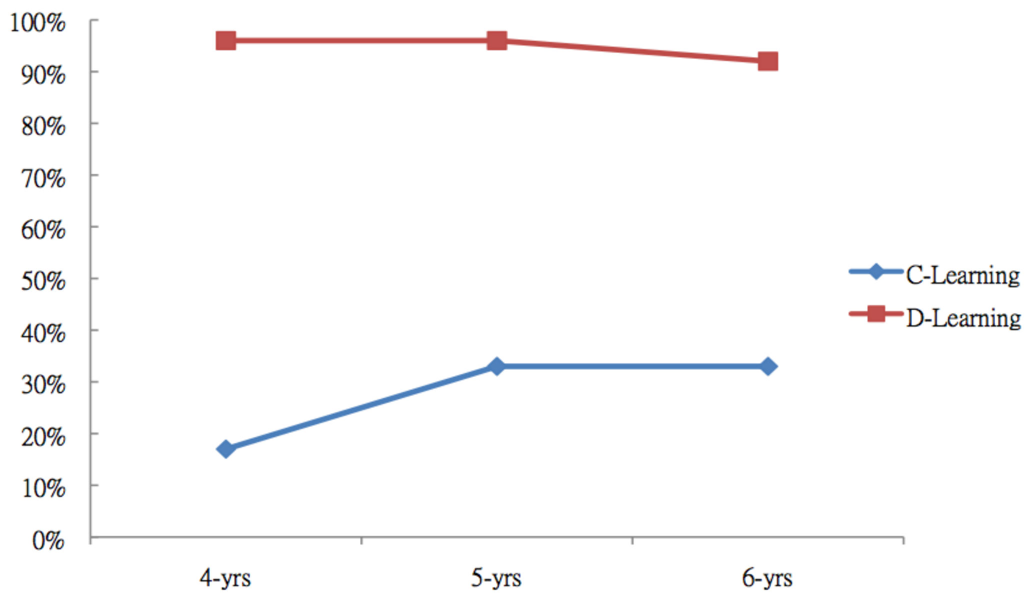

Figure 5.2. Percentage of correct responses by age for Learning questions in Study 2.

Six-year-olds' difficulty with the C-Learning question was in conflict with their unanimously correct response on C-Knowledge as shown in Figure 5.1. That is, even when older children answered correctly that the person in the *Coincidence* tasks did not know, a large proportion of them still thought the same person had learned. It suggests even the oldest children did not have a coherent understanding of knowledge and learning. They probably answered the C-Knowledge question correctly simply by echoing the knowledge statement in the story. If they did understand the knowledge issue, the apparent conflict in their responses revealed a premature behavioral concept of learning, which is independent of knowledge change.

5.4.3 Prediction

The answers to the *Coincidence*-Prediction question (C-Prediction) and the *Discovery*-Prediction question (D-Prediction) were again coded twice, firstly according to the story, then adjusted according to the child's previous answer to the learning question in the same story (abbreviated as C-Prediction-ad and D-Prediction-ad in Figure 5.3).

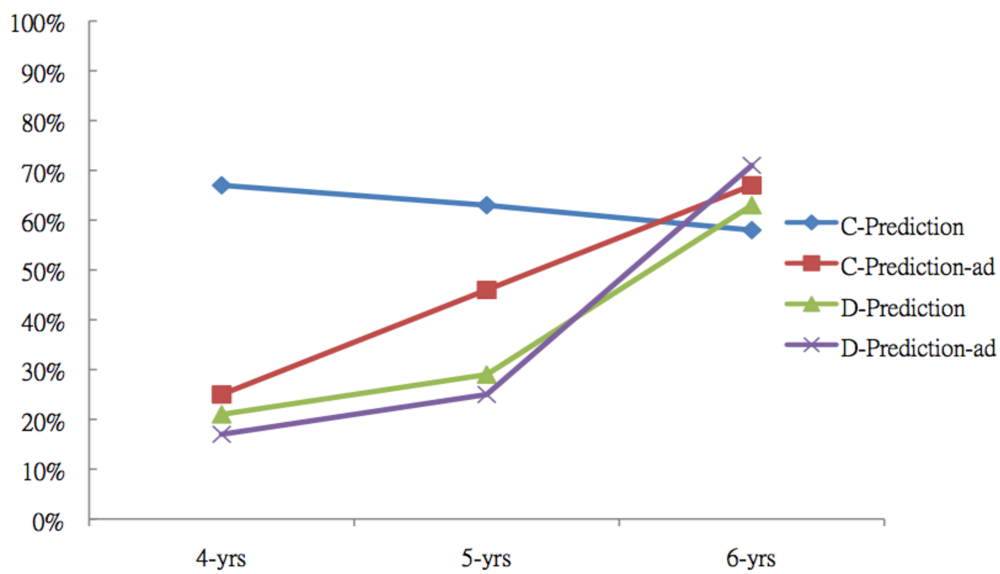

Figure 5.3. Percentage of correct responses by age for Prediction questions in Study 2.

Figure 5.3 shows the percentage of correct responses to the prediction questions in Study 2. Children's performance on prediction questions improved significantly with age, $\chi^2(2, N = 72) = 8.28, p = .016$ for C-Prediction-ad; $\chi^2(2, N = 72) = 9.82, p = .007$ for D-Prediction; and $\chi^2(2, N = 72) = 17.18, p < .000$ for D-Prediction-ad, except for C-Prediction, $\chi^2(2, N = 72) = .35, p = .839$. Similar to Study 1, children's responses on the positive prediction C-Prediction was better than the negative prediction D-Prediction, χ

$^2(1, N = 72) = 5.35$, $p = .021$. Once they were adjusted, the difference disappeared, exact $p = .238$, $N = 72$.

5.4.4 Relation between Learning and Prediction

As for the relation between learning and prediction, unlike Study 1, only D-Learning had significant advantage over D-Prediction, $\chi^2(1, N = 72) = 35.56$, $p < .000$, and D-Prediction-ad, $\chi^2(1, N = 72) = 35.56$, $p < .000$. Prediction was more difficult than learning, and the gap decreased with age, indicating children were getting a better grasp on the relation between current knowledge state and future learning. When the learning outcome was negative like in C-Learning, the responses to the predictions were significantly better than that to the learning question, $\chi^2(1, N = 72) = 14.77$, $p < .000$ for C-Prediction, and $\chi^2(1, N = 72) = 5.33$, $p = .021$ for C-Prediction-ad. The response pattern is reasonable if children overwhelmingly portrayed learning as doing. That is, doing something without a mental representation is "learning," and to do it again means one needs to "learn" it again.

5.4.5 Correlation between Learning / Prediction and ToM in Study 1 and Study 2

Children in this study and all the following studies participated in ToM measure using Wellman and Liu's (2004) scale. Overall, 198 children from CQ and 75 children from Hong Kong (abbreviated as HK below) participated in all 6 studies. The results were analyzed using Guttman scaling and Rasch modeling. Detailed data analyses are described in *Chapter Ten*.

Five items in the ToM measure formed a less than perfect but still reasonable developmental scale. Children's five-item Rasch scale scores correlated perfectly with their five-item Guttman scores, which is the simple sum of correct answers, $r(198) = .998$,

$p < .000$ for the CQ sample, and $r(75) = .998$, $p < .000$ for the HK sample. For the purpose of illustrating the correlation between ToM and learning understanding, five-item Guttman score was used for its simplicity in calculation. For the CQ sample, children's ToM score was correlated with age in months, $r(198) = .47$, $p < .000$. The same was true for the HK sample, $r(75) = .39$, $p < .000$.

As further discussed in *Chapter Ten*, the Guttman scaling and Rasch modeling of the ToM scale did not form a perfectly lined-up equal-distance 5-item scale in both the CQ sample and the HK sample, as Wellman and colleagues' found with other samples (Peterson, et al., 2005; Peterson & Wellman, 2009; Wellman & Liu, 2004; Wellman, et al., 2006). It is argued that the ToM development is not entirely culturally universal. Variations in the sequence of the mental concepts' development decrease the validity of ToM measure as a scale to a certain extent. To compensate for this, two items in ToM scale that were specified as false belief tasks by the authors, *Explicit False Belief* and *Contents False Belief*, were summed up as an index of false belief understanding.

Correlations between Learning/Prediction and each item in the ToM scale found close connections between Learning/Prediction, especially Learning, and two items in the ToM scale: *Contents False Belief* and *Knowledge Access*. Closer examination of the two items found they both asked about the character's knowledge state and belief, and they shared more similar story structure and question format than the two false belief tasks, which might explain why they were more closely related to the task questions in learning stories. The sum of these two items also function as an indicator of mental state understanding in the discussions of correlation between learning understanding and ToM. The fourth indicator of ToM is C-knowledge, as discussed under *5.4.1*.

Table 5.3

Correlation between ToM indicators and Learning / Prediction in Study 1 and Study 2

	ToM	False Belief	*Contents FB* and *Knowledge Access*	C-Knowledge
Zero-order correlation(df = 66)				
Learning	.28*	.30*	.36**	.41***
	(.020)	(.012)	(.003)	(.000)
Prediction	.20	.37**	.30*	.39**
	(.100)	(.002)	(.014)	(.001)
Controlling for age (df = 65)				
Learning	.18	.20	.27*	.33**
	(.144)	(.109)	(.025)	(.006)
Prediction	-.0.3	.16	.10	.22
	(.827)	(.193)	(.429)	(.075)

Note. Numbers in parentheses are *p* values.

*: $p < .05$;

**: $p < .01$;

***: $p < .001$.

Since the same group of children participated in both Study 1 and Study 2, combining the Learning and Prediction results from the two studies gives more variance to the Learning and Prediction indexes. Table 5.3 shows the correlation between the Learning and Prediction indexes and ToM Guttman score, the sum of *Contents False Belief* and *Explicit False Belief*, the sum of *Contents False Belief* and *Knowledge Access*, and knowledge understanding. Learning significantly correlated with all four variables; the correlation between Learning and the sum of *Contents False Belief (FB)* and *Knowledge Access* remained significant even after controlling for age, so did the one between Learning and C-Knowledge. Prediction significantly correlated with multiple

ToM indicators except for the total ToM score; but the correlations were no longer significant after controlling for age.

5.4.6 Adults' Data

Adults' responses on learning tasks in Study 2, 4, and 6 were also collected. As mentioned before, adult participants were recruited from an east coast university in USA and a university in CQ, China. Instead of having an experimenter to read the stories to the participants, adults were given a booklet of the learning tasks in random order to read and answer the questions by ticking the corresponding boxes. The correct percentage of adults' responses to questions in Study 4 and 6 were all above 80%; and there were no significant differences between American adults and Chinese adults, indicating the tasks concern culturally universal knowledge that is common sense to adults. However, results from Study 2 were less perfect and therefore interesting.

There were 25 US adults and 29 Chinese adults participated in Study 2. They were given two versions of the *Coincidence* and *Discovery* tasks. In addition to the letter *O* task, there was another similar letter *V* task, where the character drew a tick mark that resembled a letter *V*. A few participants answered the control questions incorrectly; their responses on that specific task were excluded from the analyses.

Figure 5.4 shows the average percentage of correct responses to the Learning questions and the Prediction questions of both American and Chinese adults. American adults did well on all the Learning and Prediction questions. Chinese adults, on the other hand, were less successful in *Coincidence*-Learning (C-Learning) question and both of the Prediction questions. The differences between the American and the Chinese were significant, $F(1, 48) = 8.17$, $p = .006$ for C-Learning; $F(1, 48) = 5.67$, $p = .021$ for

Coincidence-Prediction (C-Prediction); and $F(1, 48) = 8.09$, $p = .007$ for *Discovery*-Prediction (D-Prediction).

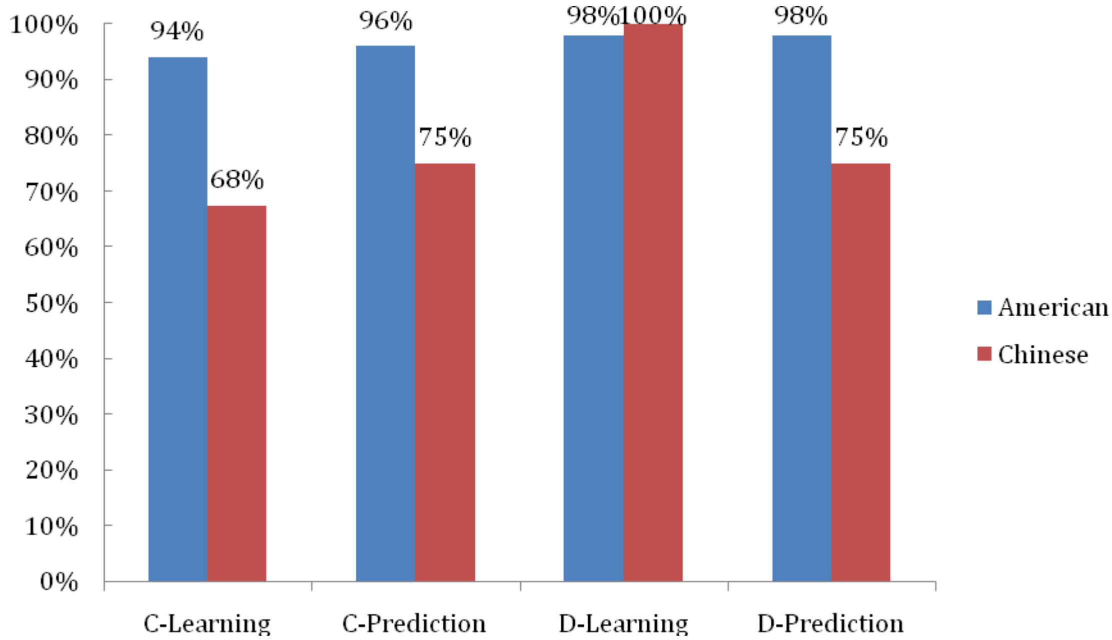

Figure 5.4. Average percentage of correct responses to Learning and Prediction questions of American and Chinese adults.

5.5 Discussion

The results of Study 2 suggested that children identified behavioral change as learning, regardless of whether the behavioral change involves a mental representational change. Younger children tended to answer both knowledge state questions with *Yes;* while older children tended to answer both questions with *No.* A closer examination of children's response and evidence from adults' data suggested that younger children equated doing with knowing while older children thought the two questions were both asking about the character's initial knowledge state. Younger children answered affirmatively to the knowledge state questions, indicating they treated the behavioral change just the same as the knowledge change. Older children, on the other hand, realized that a simple behavioral change was not sufficient for knowledge change. Even so, children still found the learning question in *Coincidence* story extremely difficult, suggesting an incoherent understanding of knowledge and learning.

In terms of learning prediction, the results replicated those found in Study 1. Younger children made predictions based on the assumption that if one learned before, s/he was more likely to “learn” the same content in the future. Older children, on the other hand, were more likely to reason that if one already knew something, s/he did not need to learn it again, and vice versa.

Not only children, Chinese adults too, over-attributed learning. A substantial proportion of Chinese adults believed a behavioral change was learning. And they were less capable of predicting learning in the future based on learning outcome. Take the *Discovery* task as an example, although Chinese adults unanimously agreed the character learned in the story, quite a few still thought the character would need to learn in the future. The culture specific phenomenon might relate to the *learning as a virtue* belief (Li, 2001, 2002, 2004) of Chinese people. Li argued that the Chinese culture emphasizes persistence and diligence in learning, instead of epistemological knowledge change. Therefore a behavioral act such as practice is considered learning. Following that line of argument, there is always room to improve in learning. In fact when asked why they responded the way they did, several Chinese adults commented that the character could always use more practice. This result calls for caution when extending the findings of current study to other populations.

To summarize, Study 2 replicated Study 1 in suggesting that children have a behavioral understanding of learning. They overwhelmingly reported that a person whose action resembled the behavioral outcome of learning, but without a mental representational change, learned. Combining results from Study 1 and 2, it was found that children's understanding of learning as knowledge change was significantly correlated with their mental state understanding, especially with knowledge change. Chinese adults, but not American adults, over-attributed learning too, which might be a culture specific phenomenon in the beliefs about learning.

CHAPTER SIX

Study 3: Content Familiarity

Study 3 serves two purposes: firstly, it replicates Study 2's design in comparing children's understanding of *Coincidence* vs. *Discovery* in multiple tasks, but using a forced choice question format. Younger children are affected by affirmation bias; they tend to give *Yes* answers to *Yes* or *No* questions (Fritzley & Lee, 2003). Asian children's *Yes* bias prolongs even later in life, and exhibits a fairly different pattern from North American children (Okanda & Itakura, 2008). By adopting a forced choice question format, Study 3 may obtain more accurate information on children's learning judgment.

Secondly, Study 3 contrasts children's learning judgment in familiar versus unfamiliar tasks to examine whether children's familiarity with the learning contents affects their judgment. As reviewed previously, children are subject to epistemic egocentrism in knowledge understanding. They tend to think others have the same knowledge as they do, and over-attribute knowledge to themselves too. The question remains whether their own knowledge state affects their learning judgment. If children themselves do not have that knowledge, do they still over-attribute it to others?

6.1 Design

Six tasks were designed, including 3 familiar content tasks and 3 unfamiliar content tasks. The familiar tasks involved copying a word with which children were already familiar (the Copy task); writing a symbol that happened to resemble a familiar Chinese character (the Double Identity task); and putting three number blocks together that happened to spell a familiar word (the Block task). The three unfamiliar tasks involved copying a word that children were not familiar with; writing a symbol that happened to resemble a word in a foreign language; and putting three letter blocks together that spell a made-up word.

Study 3 was designed to have two characters in each story, one of whom learned the content while the other did not. Participants were introduced to the two characters, and were told they could not do something. They were asked right after the statement whether each of the characters could perform the action of interest. After the learning event, the participants were again asked about the character's knowledge state, and whether or not the character had learned the content in the story. In the end, a forced choice question asked participants that out of the two characters, which one learned. The presentation sequence of character A and B was counterbalanced in the stories. Sample stories of Study 3 can be found in Appendix D. An example of the stories reads like this:

> There is a planet called Emma in the Milky Way. People on Planet Emma speak Emma language. Do you know how to spell Pen in Emma language? This is how you spell Pen in Emma language: W-U-P.
>
> These are Bing and Sim Yee. They cannot spell Pen in Emma language. They just can't.
>
> Can Bing spell Pen in Emma language?
>
> Can Sim Yee spell Pen in Emma language?
>
> Today in school, Bing and Sim Yee each put three letter blocks together: W-U-P. They spell just like the word Pen in Emma language, don't they?
>
> Bing shows his blocks to Mickey Mouse. Mickey Mouse says to Bing: "This is how you spell Pen in Emma language. You just spelled Pen in Emma language." Now Bing knows this is how you spell Pen in Emma language. He knows this is Pen in Emma language.
>
> Does Bing know this is how you spell Pen in Emma language?
>
> Did Bing learn how to spell Pen in Emma language today?
>
> Sim Yee shows her blocks to Donald Duck. Donald Duck says to Sim Yee: "This is a line of blocks. You just did a good job putting these blocks together." Only Sim Yee does not know this is how you spell Pen in Emma language. She does not know this is Pen in Emma language.
>
> Does Sim Yee know this is how you spell Pen in Emma language?
>
> Did Sim Yee learn how to spell Pen in Emma language today?
>
> Who learned how to spell Pen in Emma language today, Bing or Sim Yee?

6.2 Participants

Data were collected in Hong Kong. Seventy-five children from 2 preschools and 2 primary schools were recruited. The preschools and primary schools represented a wide range of social economic status neighborhoods in Hong Kong. There were 39 boys and 36 girls, ranging from 48 months to 86 months (M = 65.45, SD = 11.45), including 25 4-year-olds (M = 52.80, SD = 3.22, 11 girls and 15 boys), 25 5-year-olds (M = 64.52, SD = 3.81, 12 girls and 13 boys), and 25 6-year-olds (M = 79.04, SD = 4.38, 13 girls and 12 boys). Informed consents were collected from parents.

6.3 Materials and Procedures

The materials and procedures were similar to that used in the previous studies, with the exception of employing two Disney figures such as Winnie the Pooh and Tiger, or Mickey Mouse and Donald Duck as teachers instead of Teletubby. The 6 stories were presented to children in random order. Children finished the learning stories from this study, together with stories from Study 5 and the ToM scale in two to three sessions of 15 minutes each in random order. All tasks were administrated in Cantonese. Minor linguistic adjustments were made in presenting the stories to adapt to the language custom in Hong Kong.

6.4 Results

Some children responded that both of the characters learned in the forced choice questions, which was coded as incorrect. Out of the 25 6-year-olds, 4 children only finished the ToM battery but not the learning tasks. Their responses on the learning tasks were excluded from the analyses. The three familiar tasks as well as the three unfamiliar tasks were designed as homogenous tasks; therefore responses on the three tasks were combined using sums in the following analyses. There were no significant differences between boys' and girls' performances.

6.4.1 Comparison between Coincidence and Discovery

For the convenience of comparison across studies, Figure 6.1 illustrates the average percentage of correct responses on the knowledge questions across the 3 versions of the tasks instead of the sum of the 3 versions. Even though the characters' knowledge states were explicitly stated in the stories, children tended to reprocess the information. Overall, C-Knowledge and D-Knowledge did not differ significantly from each other, $t(69) = 1.38$, $p = .172$ for familiar tasks; $t(69) = -.42$, $p = .675$ for unfamiliar tasks. However, similar to Study 2 (see Figure 5.1), C-Knowledge and D-Knowledge demonstrated different developmental patterns. On the one hand, C-Knowledge improved significantly with age, $F(2, 67) = 11.36$, $p < .000$ for familiar tasks, $F(2, 67) = 8.62$, $p < .000$ for unfamiliar tasks. By 5 years old, children were quite good at differentiating doing from knowing. D-Knowledge, on the other hand, stayed virtually the same across three age groups, $F(2, 67) = .04$, $p = .961$ for familiar tasks, $F(2, 67) = .485$, $p = .618$ for unfamiliar tasks. The result replicated the discrepancy between C-Knowledge and D-Knowledge, as well as the dramatic increase in C-Knowledge found in Study 2, suggesting it is a critical period between 4 and 6 years for children to understand the mental property of knowledge.

Again, similar to Study 2 (see Figure 5.2), children in the current study found D-Learning easier than C-Learning (see Figure 6.2), $t(69) = 3.56$, $p = .001$ for familiar tasks; $t(69) = 4.22$, $p < .000$ for unfamiliar tasks. They tended to believe that both *Discovery* and *Coincidence* were learning. Within *Discovery* stories, children's responses of the D-

Knowledge questions did not differ from that of D-Learning questions, $t(69) = .28$, $p = .778$ between the two in familiar contexts; $t(69) = .30$, $p = .765$ between the two in unfamiliar contexts. However, significant discrepancies between the C-Knowledge and C-Learning questions replicated what was found in Study 2: $t(69) = 8.03$, $p < .000$ between the two in familiar contexts; and $t(69) = 5.94$, $p < .000$ between the two in unfamiliar contexts. Children did better on C-Knowledge questions than on C-Learning questions; that is, they responded that the person in the *Coincidence* stories did not know, but learned.

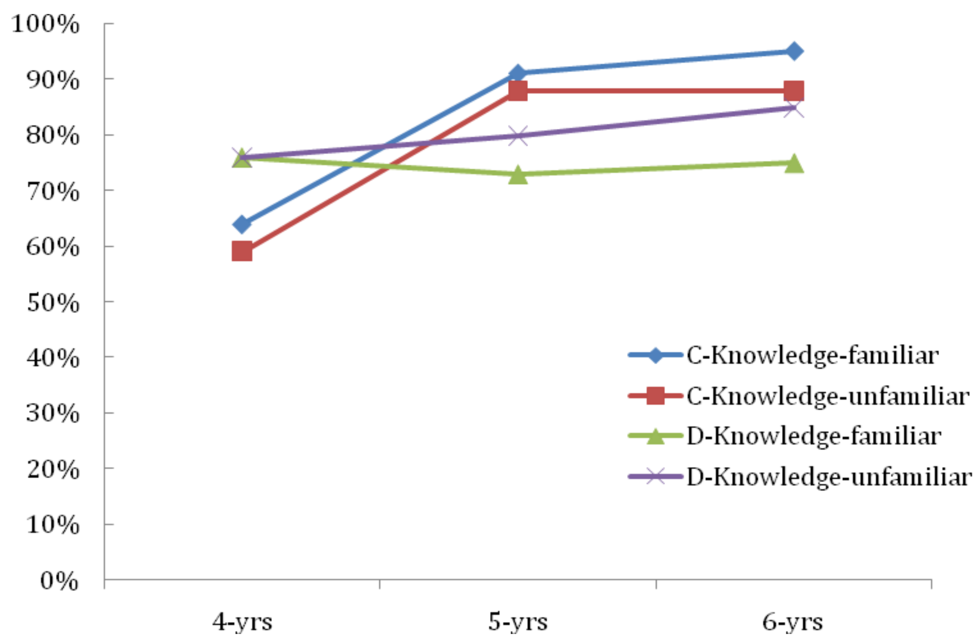

Figure 6.1. Average percentage of correct responses by age for Knowledge questions in Study 3.

The age differences were not statistically significant for C-Learning, $F(2, 67) = 2.62$, $p = .081$ for familiar tasks; $F(2, 67) = 2.08$, $p = .121$ for unfamiliar tasks. There were significant age differences in D-Learning though, $F(2, 67) = 4.02$, $p = .022$ for familiar tasks; and $F(2, 67) = 6.03$, $p = .004$ for unfamiliar tasks. As puzzling as it is, with the increase of age, especially between 5 and 6 years old, children's response to the D-Learning questions decreased to a random level, as shown in Figure 6.2. A closer examination found that out of 20 6-year-olds who had finished all the learning tasks, seven of them answered D-Learning questions in both familiar and unfamiliar contexts totally incorrectly; they scored 0 out of 3 possible points in both contexts, which is extremely rare in other age groups, with only one case in 4 years old group. Eight children out of the remaining thirteen 6-year-olds answered D-Learning questions in both familiar and unfamiliar contexts totally accurately with a maximum score of 3. This is a sign that 6-year-olds were not responding to the D-Learning questions entirely by chance as it appeared in Figure 6.2. It rather suggested that the seven children who got the D-Learning questions wrong had an unusual interpretation of the tasks.

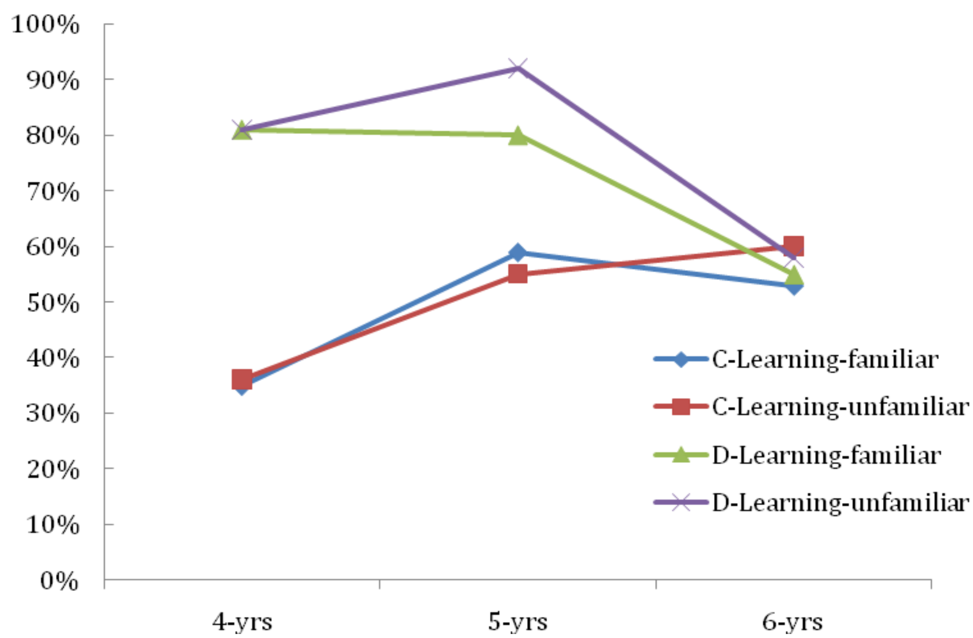

Figure 6.2. Average percentage of correct responses by age for Learning questions in Study 3.

6.4.2 Difference between Familiar and Unfamiliar Learning Contents

Figure 6.3 shows the means of the forced choice learning questions in familiar and unfamiliar tasks by age in Study 3. There were no significant differences between familiar tasks and unfamiliar tasks in the learning questions, $t(69) = .591$, $p = .557$. However, the patterns of the two were different from each other. The mean of unfamiliar tasks stayed almost the same with the increase of age, $F(2, 67) = .24$, $p = .791$; whilst the mean of familiar tasks increased significantly with age, $F(2, 67) = 5.69$, $p = .005$, suggesting the familiarity to the learning contents did affect children's learning judgment.

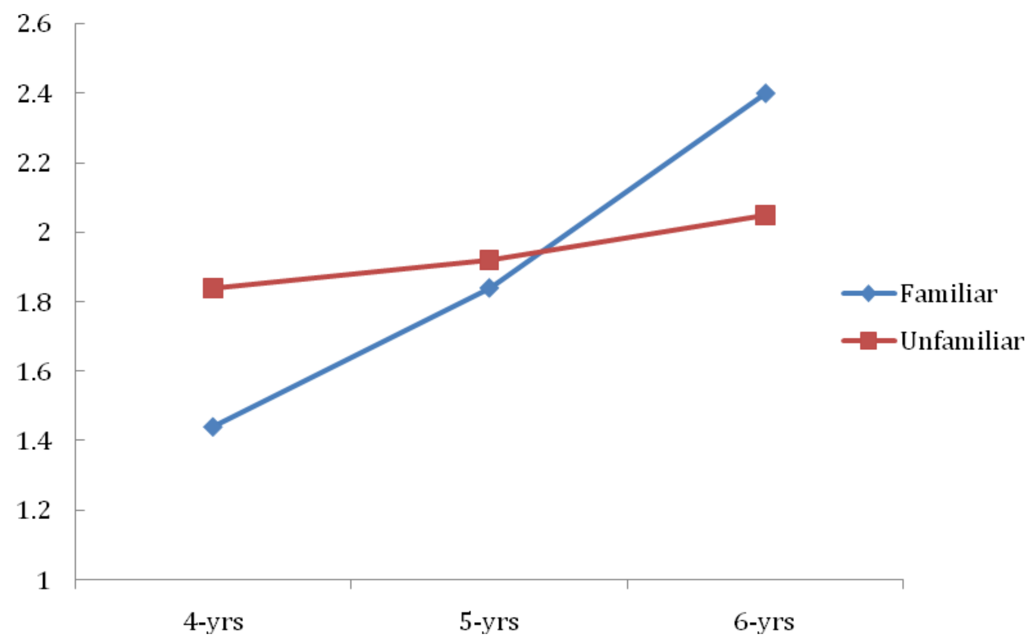

Figure 6.3. Means of Learning questions in familiar and unfamiliar tasks in Study 3.

6.4.3 Correlation between Learning and ToM

Table 6.1 shows the correlation between ToM indicators and children's learning judgments in the forced choice questions. Similar to Study 1 and 2, Study 3 found significant correlation between learning judgments and knowledge state understanding, especially knowledge state understanding in unfamiliar learning tasks. C-knowledge in familiar tasks was correlated significantly with learning judgments in familiar tasks, before and after controlling for age. C-knowledge in unfamiliar tasks was correlated significantly with learning judgments in both familiar and unfamiliar tasks, before and after controlling for age.

Table 6.1

Correlation between ToM indicators and forced choice Learning questions in familiar and unfamiliar tasks in Study 3

	ToM	False Belief	Contents FB and Knowledge Access	C-Knowledge-familiar	C-Knowledge-unfamiliar
Zero-order correlation(df = 68)					
Familiar	.12	.24*	.22	.43***	.38**
	(.320)	(.045)	(.070)	(.000)	(.001)
Unfamiliar	-.10	.09	-.03	.04	.31**
	(.394)	(.442)	(.826)	(.738)	(.008)
Controlling for age (df = 67)					
Familiar	-.05	.07	.04	.31*	.28**
	(.695)	(.550)	(.751)	(.010)	(.008)
Unfamiliar	-.15	-.06	-.08	.00	.31*
	(.208)	(.615)	(.526)	(.983)	(.010)

Note. Cells contain Pearson correlations. Numbers in parentheses are *p* values;

*: $p < .05$;

**: $p < .01$;

***: $p < .001$.

6.5 Discussion

When the task questions addressed each character's knowledge state and learning separately, a discrepancy between *Discovery* and *Coincidence* again was present. Even though their responses to knowledge state questions did not differ significantly between the two conditions, children came to realize between 4 and 6 years of age that doing something without the symbolic appreciation does not count as knowing. However, there was still a major gap between children's learning judgments in *Coincidence* and that in *Discovery*; they tended to think of both conditions as learning. As found in Study 2, even when children could answer the C-Knowledge questions correctly, they answered the corresponding C-Learning questions significantly worse, indicating lack of coherence in their knowledge and learning understanding and behavioral learning judgment independent of knowledge status. Some 6-year-olds showed an unusual pattern in responding to the D-Learning questions. Considering their good performance in the knowledge state question, it might be the case that they read too much into the *Discovery* tasks.

Once forced choice was adopted, children's response to the learning question revealed an improvement with age, at least in familiar context. With the increase of age, more and more children realized knowledge change is a necessary condition for learning. For younger children, knowing the learning contents themselves was likely to trigger epistemic egocentrism that hindered learning judgment. They would think other people knew what they knew; therefore picked randomly between the two characters. Older children with increased awareness of the mental properties of their own knowledge and learning were more likely to transfer their own experience to other people through simulation, which helped their learning judgment in familiar tasks. When children were not familiar with the learning contents, however, they were neutral in the judgment and therefore less affected by either epistemic egocentrism or simulation.

Children's learning judgment did correlate with their mental state understanding, but not mental state understanding in general as measured by ToM scale. Children's learning judgment correlated with their understanding of knowledge states and change, especially the knowledge state in unfamiliar learning context. The lack of familiarity with the learning content might help children to realize: if I don't know this, the learner in the story probably does not either.

To summarize, Study 3 replicated Study 2 in finding that young children over-attributed knowledge to those who could perform the action associated with knowledge but without the mental representation. By 5 years old, children were able to differentiate doing from knowing. Even though children's learning judgments of single incidences were non-decisive, their responses to the forced choice learning question, especially in familiar contexts, improved with age. Children's learning judgments in unfamiliar contexts remained the same across the three age groups. Out of several mental state understanding indicators, children's learning judgments correlated significantly with knowledge state understanding.

6.6 General Discussion for Study 1 to Study 3

The first three studies examined children's understanding of knowledge change in learning. Children's understanding of learning as knowledge change develops during preschool years. As reviewed previously, children begin to use the mental verbs including *learn* and *teach* early in life, and show a gradual understanding of knowledge state and knowledge change in teaching and learning. The current study adds to the literature in explaining the developmental characteristics and processes from a behavior based concept of learning to a knowledge based concept of learning.

Similar to children's action but not mental representation based pretense judgment (Lillard, 1993; Sobel, 2007), results from Study 2 and Study 3 revealed that preschool children did not differentiate *knowing/learning* from *doing;* they were drawn to the resemblance between a behavioral change and learning and tended to over-attribute learning to events without a genuine knowledge change. Both knowledge understanding and executive function might contribute to children's difficulty on tasks without genuine knowledge change. However, Asian children were reported to have precocious development in executive function, including working memory and inhibitory control, but not a correspondingly advanced, if not at all delayed, ToM development compared to Western children (Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Tardif, So, & Kaciroti, 2007; Oh & Lewis, 2008). By 3.5 or 4 years of age, Asian children already develop an above-chance level of inhibitory control. However, within a specific culture, inhibitory control still correlates with ToM development (Sabbagh et al., 2006; Oh & Lewis, 2008). Further studies should consider measuring children's executive function together with *mindful learning* in order to examine the relationship between domain general cognitive ability and domain specific understanding of learning.

Chinese adults too over-attributed learning. They tended to consider behavioral acts as learning, and think a person always needs to learn to improve. It is suspected that cultural beliefs toward learning instead of restricted mental state understanding were responsible for their difficulty with the learning tasks since they responded well to other learning tasks. However, since children participants were recruited from China, caution should be taken when extending the findings to a broader population.

Taylor et al. (1994) found children were better able to report their own learning in cases of novel knowledge than that of familiar knowledge. Study 3 found children's familiarity with the contents also affected their judgment of whether another person learned. However, the effect of familiarity seemed to work differently with children of different ages. There was a significant improvement in children's learning judgment in familiar learning context from 4 to 6 years of age. Children's learning judgment in novel learning contexts, however, remained unchanged from 4 to 6 years of age. The strong correlation between learning judgment and knowledge state understanding, especially in unfamiliar contexts, revealed an effect of epistemic egocentrism.

Across the first three studies, learning judgment was strongly correlated with children's ToM ability represented by knowledge state understanding, which confirms that knowledge change is necessary condition for learning, and understanding of knowledge state and change is the primary component in children's *mindful learning* development.

If the need to learn is based on knowledge state, one's learning intention is based on belief, independent of the real knowledge state. When one has an accurate estimate of one's own knowledge state, that is, when the knowledge state and the belief is consistent, one's learning intention is consistent with the need to learn. However, when one has an inaccurate estimation of one's own knowledge state, in other words, when there is a conflict between belief and knowledge state, which happens in real life very often, the learning intention becomes complicated. In the next chapter, the discussion focuses on the effect of children's understanding of (false) belief about the knowledge state on learning intention.

CHAPTER SEVEN

Study 4: Belief about the Knowledge State

The ancient Greek philosopher Socrates claimed the only wisdom he had was the awareness of his own ignorance. Defending himself in the trial that lead to his death, Socrates said, according to Plato's *Apology of Socrates*, “I neither know, nor think I know.” In epistemic terms, *knowing you (don’t) know* is a second order mental state concept that concerns awareness of one’s own knowledge state. It is an important component in *mindful learning,* because it determines whether one has an intention to learn, before one even starts to learn. One needs to learn when one does not know; yet one will only try to learn when one believes s/he does not know. People do not always have an accurate estimation of their own knowledge state though. Often times we are over-confident about the depth and scope of our knowledge. How would children predict the need to learn and the learning intention when there is an over- or under-estimation of a knowledge state? Study 4 examines children’s understanding of belief about the knowledge state.

7.1 Design

Four tasks were designed in this study involving true or false belief about a character’s knowledge state. The true belief stories involved a character who either knew s/he knew (*Positive Knowledge and Belief,* abbreviated as PKB), or knew s/he did not know (*Negative Knowledge and Belief,* abbreviated as NKB). The false belief stories involved a character who either did not know s/he knew (*Under-Estimating Knowledge,* abbreviated as UEK) or did not know s/he did not know (*Over-Estimating Knowledge,* abbreviated as OEK) (for examples of stories in Study 4, see Appendix E). The task questions asked whether this person needed to learn (the *Necessity* question), and whether this person would try to learn (the *Intention* question), based on the character's knowledge state and belief. Control questions about the character's actual knowledge state and belief were asked before the task questions. Task specifications are listed in Table 7.1.

Table 7.1

Task specifications of Study 4

	Knowledge state	Belief	Would the person need to learn?	Would the person try to learn?
PKB	+	+	No	No
NKB	-	-	Yes	Yes
UEK	-	+	Yes	No
OEK	+	-	No	Yes

The *Necessity* questions should be easier than the *Intention* questions since as long as children appreciate knowledge as an enduring mental state, they should be able to tell whether those who have a positive or a negative knowledge state need to learn. However, only when children understand that people act upon their belief, even it is a false belief, could they correctly predict the learning intentions based on beliefs independent of the actual knowledge states.

Out of the four tasks in this study, the UEK task requires a specific learning content for the learner to not know s/he really knows. The story was designed to have a person singing a song with the title unknown to him/her. Because of the restriction on this particular task, the learning contents could not be fully counterbalanced. Nevertheless, to block the potential effect of the content to a maximum level, the learning contents of the other 3 tasks were counterbalanced using a Latin Square design, which means each one third of the participants shared a common content in each of the remaining three stories. Meanwhile, all participants shared the same content in the UEK task. A sample UEK story reads like this:

> Do you know how to sing the Bingo Song? Can you sing it for me?
>
> This is Leo. Today in school Teletubby asks Leo: "Can you sing the Bingo Song?" Leo says: "No, I can’t." But actually Leo can sing this song: “There was a farmer had a dog and Bingo was his name oh.”
>
> Can Leo sing the Bingo Song?
>
> Only Leo does not know that song is called the Bingo Song. He does not think he can sing the Bingo Song.
>
> Does Leo think he can sing the Bingo Song, or does he think he cannot sing the Bingo Song?
>
> When Leo goes home after school, He said to himself: "I want to sing the Bingo Song." Leo wants to sing the Bingo Song.
>
> Does Leo need to learn how to sing the Bingo Song?
>
> Will Leo try to learn how to sing the Bingo Song?

7.2 Participants

Participants were recruited from CQ, China, the same city where participants of Study 1 and 2 were recruited. Children in this study had not participated in previous studies. This study involved false belief understanding, which is a more challenging task compared to knowledge understanding in previous studies. Based on the results of previous studies as well as the literature on Chinese children's less advanced performance on false belief tasks (Sabbagh, et al., 2006; Wellman et al., 2006; Liu et al., 2008), Study 4 only recruited children that were 5 and 6 years old, but not 4 years old. Fifty-five children from 59 to 99 months participated in Study 4 (M = 72.00, SD = 10.28), including 21 girls and 34 boys. There were 28 children at 5 years from 59 to 71 months

(M = 63.57, SD = 3.20), including 10 girls and 18 boys; and 27 children 6 years and up from 72 to 99 months (M = 80.74, SD = 7.28), including11 girls and 16 boys. Informed consents were obtained from parents.

7.3 Materials and Procedures

The materials and procedures used in this study were similar to those in Study 1 and 2. The procedure unique to this study was that after the knowledge state was demonstrated on a piece of paper, depending on the story, the experimenter made either a thumb-up or waving gesture indicating the character's belief. For the singing task, instead of writing on a piece of paper, the experimenter sang the song. Songs used in this study were chosen after consulting children's classroom teachers to make sure children were familiar with them. The criterion for choosing the songs was the first sentence of the lyrics does not contain the title.

Two questions were asked before the task questions, including a knowledge state question and a belief question. The child should be able to answer the knowledge state question correctly before moving on to next questions. If not, the experimenter retold the story and asked the knowledge state questions again. Pilot testing had shown that false belief stories were especially difficult for children. They often failed to answer the belief questions correctly, even when the question followed the belief statement immediately. The response to the belief questions hence became an index of children's false belief understanding. The experimenter moved on to task questions no matter whether the child answered the belief question correctly or not. The sequence of the two task questions, the *Necessity* question and the *Intention* question, was counterbalanced.

The four tasks were presented in random order. Each child finished the ToM battery and the belief tasks in one session of about 15 minutes. The ToM battery and the belief tasks were presented in a random order. All tasks were administrated in Mandarin.

7.4 Results

There were three children who each had one incorrect response in knowledge state control questions and their responses on that specific story were excluded from the analyses. There were no significant differences between boys' and girls' performances.

7.4.1 Belief about the Knowledge State

Figure 7.1 shows the percentage of correct responses on the belief questions in Study 4. Children's performances on belief questions improved with age; however, the age differences were not statistically significant. Children's performance on the 4 tasks were significantly different from one another, $\chi^2(3, N = 52) = 11.40$, $p = .010$. The two true belief tasks were easier than the two false belief tasks. Even though the correct answers to PKB-Belief and OEK-Belief were both *Yes*, the true belief task PKB-Belief was significantly better than the false belief task OEK-Belief, exact $p = .002$, $N = 54$. Within the two true belief tasks, children did better on the positive PKB-Belief than the negative NKB-Belief; the difference was not statistically significant though, exact $p = .375$, $N = 54$. Notice that within the two false belief tasks, the correct answer to UEK-Belief was *No* and the correct answer to OEK-Belief was *Yes*. Nevertheless, children did better on the UEK-Belief than the OEK-Belief, even though the difference was not statistically significant, $p = .344$, $N = 53$.

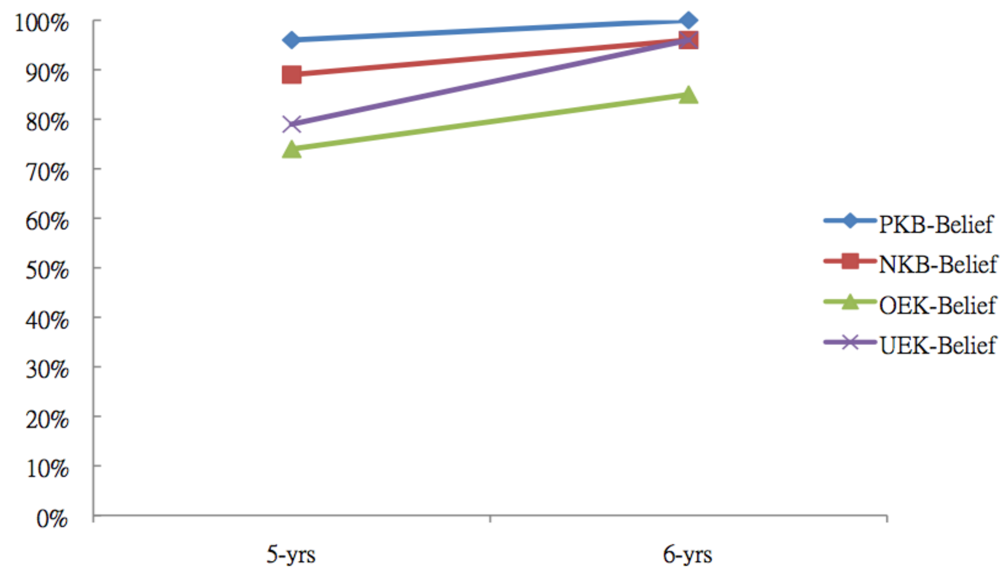

Figure 7.1. Percentage of correct responses by age for Belief questions in Study 4.

7.4.2 Learning Necessity

Figure 7.2 shows the percentage of correct responses to the *Necessity* questions in Study 4. Children's performance on the necessity questions generally improved with age. A significant age difference was found in PKB-Necessity, z = -2.00, N = 55, p = .045. Unlike the belief questions where children's responses differed between true belief tasks and false belief tasks, children's answers on the *Necessity* questions differed significantly between questions with *Yes* answers and those with *No* answers, $\chi^2(1, N = 54) = 5.33$, $p = .021$, between PKB-Necessity and NKB-Necessity; and $\chi^2(1, N = 53) = 5.60$, $p = .018$, between OEK-Necessity and UEK-Necessity. Children tended to say: "Yes, the person will need to learn," no matter whether the person had the knowledge or not. At 6 years of age, children's performances on true belief tasks improved, compared to that on false belief tasks; yet still, they answered the *Necessity* questions with negative answers at random level, binomial test's p = .59 for PKB-Necessity, and p = .22 for UEK-Necessity.

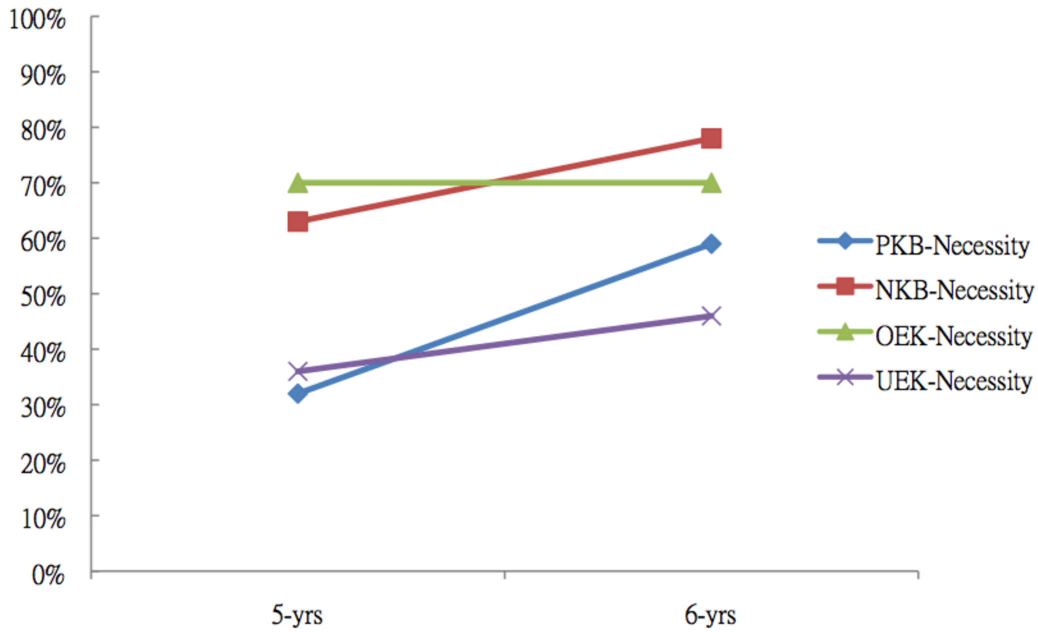

Figure 7.2. Percentage of correct responses by age for Necessity questions in Study 4.

7.4.3 Learning Intention

Figure 7.3 shows the percentage of correct responses to the *Intention* questions in Study 4. Again, the differences between children's responses to questions with *Yes* and *No* answers were significant: $\chi^2(1, N = 54) = 18.38, p < .000$, between PKB-Intention and NKB-Intention; and $\chi^2(1, N = 53) = 12.41, p < .000$, between OEK-Intention and UEK-Intention. The percentage of correct responses were higher in the false belief tasks than in the true belief tasks when comparing only those with Yes answers or No answers, but the differences were not statistically significant; exact $p = .405$, $N = 54$, between PKB-Intention and OEK-Intention; exact $p = .607$, $N = 53$, between NKB-Intention and UEK-Intention.

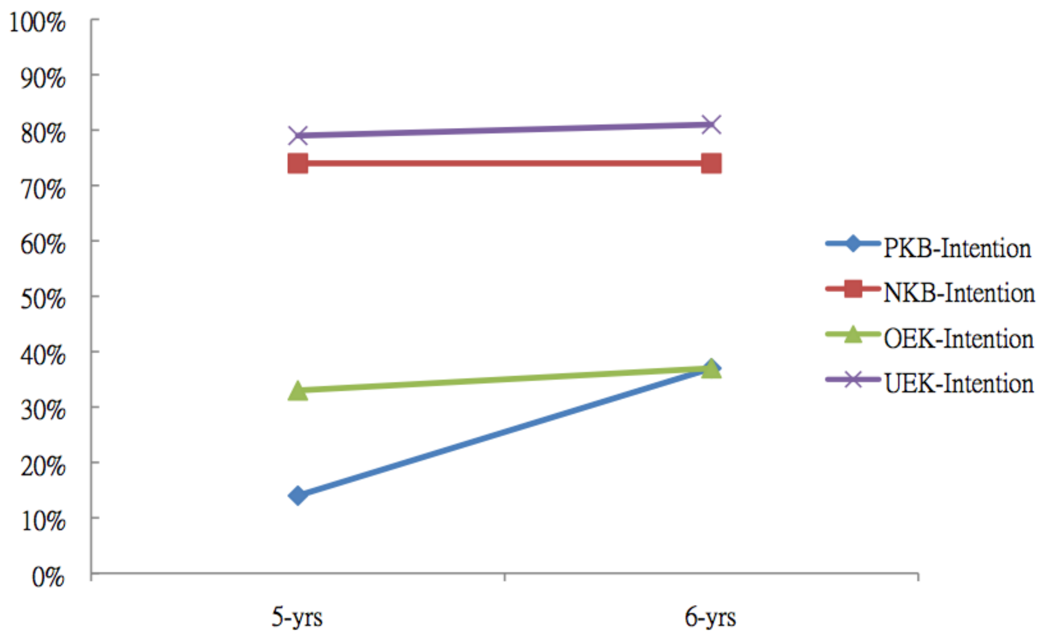

Figure 7.3. Percentage of correct responses by age for Intention questions in Study 4.

The judgment of learning intention is based on the learner's belief about the knowledge state. Therefore, children's responses on the *Intention* questions were coded the second time based on their previous answers to the belief questions (abbreviated as OEK-Intention-ad and PKB-Intention-ad). Figure 7.4 shows the adjusted percentages. Comparing Figure 7.3 with Figure 7.4, the adjustment improved the percentage on OEK-Intention significantly, exact p = .012, N = 54. Now the difference between OEK-Intention-ad and PKB-Intention-ad became significant, $\chi^2(1, N = 54) = 4.66$, p = .031.

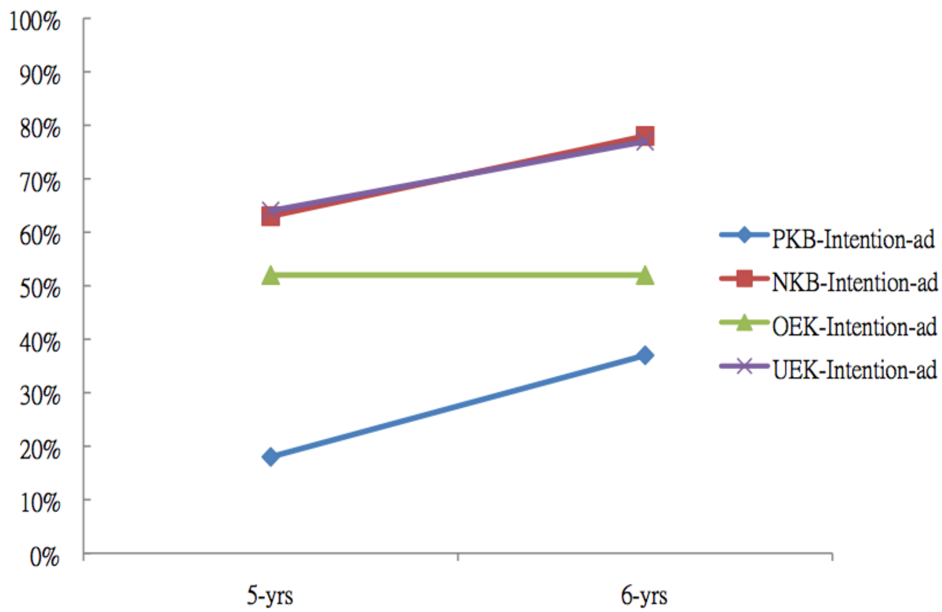

Figure 7.4. Percentage of correct responses by age for Intention questions adjusted based on Belief questions in Study 4.

7.4.4 Relation between Intention and Necessity

Children's learning predictions again were predominantly positive; they did significantly better in learning *Necessity* and *Intention* predictions when the correct answer was *Yes* than when the correct answer was *No*. It was hypothesized that children would found *Necessity* easier than *Intention*, which turned out to be true when the answers to the two questions were consistent and were both negative. The difference between PKB-Necessity and PKB-Intention-ad was significant, $\chi^2(1, N = 54) = 6.25, p = .012$. When the two answers were consistent but both positive as in the case of NKB-Necessity and NKB-Intention-ad, the percentages of correct answers were equal at 70%.

Even though the answers to the *Necessity* question and the *Intention* question in false belief tasks should not be the same like those in true belief tasks, children tended to give the same answers to the two questions. Overall, 81% children answered consistently to OEK-Necessity and OEK-Intention; and 69% answered consistently to UEK-Necessity and UEK-Intention. This is another sign that children had trouble differentiating belief-based intention from knowledge based necessity.

7.4.5 Correlation between Intention / Necessity and ToM

The sum of belief questions in the learning tasks was treated here as an indicator of belief understanding. Table 7.2 shows that none of the ToM indicators correlated with *Necessity*. ToM scale score, sum of *Contents False Belief* and *Knowledge Access*, and belief understanding correlated with *Intention* significantly. After controlling for age, ToM scale score and the sum of *Contents False Belief* and *Knowledge Access* still correlated significantly with *Intention*.

Table 7.2

Correlation between ToM indicators and Intention / Necessity predictions in Study 4

	ToM	False Belief	Contents FB and Knowledge Access	Belief
Zero-order correlation(df = 50)				
Intention	.37**	.17	.33*	.28*
	(.006)	(.240)	(.017)	(.046)
Necessity	.13	-.04	.12	.06
	(.363)	(.791)	(.379)	(.688)
Controlling for age (df = 49)				
Intention	.33*	.13	.28*	.24
	(.019)	(.372)	(.046)	(.097)
Necessity	.03	-.10	.04	-.02
	(.823)	(.474)	(.807)	(.885)

Note. Cells contain Pearson correlations. Numbers in parentheses are p values;

*: $p < .05$;

**: $p < .01$;

***: $p < .001$.

7.5 Discussion

Children generally found the belief attribution in true belief tasks quite easy; about 90% or above answered them correctly. False belief was more challenging. Considering the belief states were explicitly stated in the stories, their less than perfect performance on false belief tasks revealed a problematic belief understanding. When the character's belief was in conflict with his or her real knowledge state, children tended to reprocess the belief according to the actual knowledge state. This is not a memory issue though, since all children answered the knowledge state control questions in the same stories correctly.

Regardless of the person's belief, children's learning prediction of knowledge based necessity was overwhelmingly positive, consistent with the results from the prediction questions in Study 1 and Study 2. Their prediction of belief based learning intention, on the other hand, was affected by belief status in addition to the *Yes* bias. Even 6-year-olds found learning intention based on overestimating knowledge extremely difficult, only one third of whom answered the OEK-intention question correctly. After adjusting for their previous responses to the belief question, there were still half of the children, both 5- and 6-year-olds, answered the question incorrectly. Those who got it wrong ignored the belief status and predicted the character would try to learn since s/he really did not know. Interestingly, when the correct answer to the intention prediction question was negative, children did better in false belief task of OEK than the true belief task of PKB. After the adjustment, children's responses to intention prediction in OEK were significantly better than that in PKB. It seems the complicated belief status in OEK actually facilitated children's thinking on learning intention.

Even though children tended to answer both *Necessity* and *Intention* predictions consistently, the two questions addressed different constructs. They differed from each other in terms of their correlations with ToM indicators. Children's learning intention prediction was correlated with general ToM ability, the sum of two belief tasks in ToM scale, as well as the sum of belief questions in the learning tasks; the first two correlations remained statistically significant after controlling for age. In contrast, children's learning necessity prediction did not correlate with any ToM indicators. If children thought that learning as a behavior should be practiced as often as possible regardless of the learner's knowledge state, they certainly saw a connection between the intention to learn and belief about one's own knowledge state.

To summarize, Study 4 found that children tended to think one always needed to learn, whether one had the knowledge or not, which is consistent with previous findings. The results also revealed that children were quite good at understanding if the learner knew s/he did not know, s/he would try to learn; but if the learner thought s/he knew when s/he really did not, children up to 6 years old still believed the learner would try to learn. Children's intention prediction, but not necessity prediction, was correlated with ToM understanding. The confounding effect of *Yes* bias makes it harder to isolate the effect of belief understanding in children's learning prediction. This issue is addressed in the next study.

CHAPTER EIGHT

Study 5: Knowledge, Ignorance, and False Belief

Several factors might contribute to children's overwhelmingly positive learning prediction. The first candidate is a *Yes* bias. The second concerns the difficulty and novelty of the learning content. Study 5 further explores children's understanding of the effect of belief in learning by addressing these issues. Firstly, by adopting a forced choice question format, Study 5 examines children's learning predictions by contrasting different learners' knowledge states and beliefs side by side. Secondly, Study 5 addresses the positive learning prediction by extending the learning contents to include common sense knowledge, and evident self-knowledge such as one's own name and sex. Knowledge from the classic false belief tasks such as false location and disguised identity is also introduced to examine the connection between learning understanding and false belief understanding.

8.1 Design

Six new tasks were designed, including 2 common sense knowledge tasks (a shape of triangle, and the object of a spoon), 2 self-knowledge tasks (one's own name and sex), and 2 classic false belief tasks (location false belief and identity false belief). Three characters were involved in each of the tasks, one of who knew the knowledge of interest, the second one did not know, and the third one had a false belief. Questions were asked about each character's knowledge state, whether s/he needed to learn, and whether s/he would try to learn. In addition, participants were asked to judge who would need to learn between the knowledgeable person and the ignorant person (K/I-Necessity), or the one who had a false belief (K/FB-Necessity); as well as who would try to learn between the knowledgeable person and the ignorant person (K/I-Intention), and between the ignorance person and the one who had a false belief (FB/I-Intention) in forced choice questions. An example of the stories reads like the following (see Appendix F for details):

> Do you know these characters' names? This is Winnie the Pooh; this is Tiger; and this is Piglet.
>
> Tiger knows that his name is Tiger, he calls himself as Tiger; Piglet does not know his name, he just does not know; Winnie the Pooh thinks his name is Bunny Rabbit, he calls himself as Bunny Rabbit. Isn't he wrong!
>
> Does Tiger know his name? What does he call himself?
> Does Tiger need to learn his name?
> Will Tiger try to learn his name?
> Does Piglet know his name?
> Does Piglet need to learn his name?
> Will Piglet try to learn his name?
> Does Winnie the Pooh know his name? What does he call himself?
> Does Winnie the Pooh need to learn his name?
> Will Winnie the Pooh try to learn his name?
> Who needs to learn his own name, Piglet or Tiger?
> Who needs to learn his own name, Tiger or Winnie the Pooh?
> Who will try to learn his own name, Piglet or Tiger?
> Who will try to learn his own name, Winnie the Pooh or Piglet?

8.2 Participants

Participants were that same as in Study 3. Children finished Study 3, Study 5, and ToM measure in random order in two to three sessions of 15 minutes each.

8.3 Materials

Props used to tell the stories consisted of three laminated Smiley faces including a happy face, a frown face, and a puzzled face, a laminated picture of a triangle, a spoon, a rubber eraser in the shape of a crayon, a plastic contact lens case with two caps in different colors, a coin, and plastic figurines of Disney characters, Winnie the Pooh, Tiger, Piglet, Mickey Mouse, Minnie Mouse, and Donald Duck.

8.4 Procedures

The study started with a training section. Participants were shown the three laminated Smiley faces. They were told the happy face means one knows something; the frown face means one does not know; and the puzzled face indicates a false belief. They were then asked to point to which face indicated what knowledge state. The experimenter moved on to the learning tasks after participants understood the meaning of the Smiley faces.

The learning tasks started with asking the participant questions of interest in the stories. In the rare cases when a child did not know the character's name or whether it was a boy or a girl, the experimenter told the child. For the identity task with the disguised erasure, the child was asked what the object was before the experimenter demonstrated its true identity by erasing a pencil mark on paper. For the location task, the child was asked under which cap s/he would like to hide a coin in the contact lens case. The characters were introduced after the initial questioning. The experimenter put a corresponding Smiley face below each character as a visual reminder of the character' knowledge state when telling the stories.

The task questions included each character's knowledge state, whether s/he would need to learn, and whether s/he would try to learn. The experimenter made sure children answered the knowledge state questions correctly before proceeding to the learning prediction questions. At the end of each story, two sets of forced choice questions were asked about which one out of two candidates would need to learn or would try to learn. The sequences of the names mentioned in the forced choice questions were counterbalanced. The six tasks were presented in random order.

8.5 Results

There were a few children who answered both the ignorant person and the person with false belief would try to learn in the Ignorant/False Belief-Intention (FB/I-Intention) question. These responses were coded as incorrect. Boys' and girls' performances did not show any significant differences.

8.5.1. Consistency across Three Content Domains

Table 8.1

Means of Necessity and Intention predictions by age in Study 5.

	Age			
	4	5	6	Total
K-Necessity				
Common Sense	.56 (.87)	1.16 (.85)	1.65 (.67)	1.09 (.91)
Self Knowledge	.48 (.71)	1.24 (.93)	1.70 (.57)	1.10 (.90)
False Belief Tasks	.48 (.82)	1.44 (.71)	1.70 (.66)	1.17 (.90)
K-Intention				
Common Sense	.44 (.77)	1.08 (.81)	1.40 (.88)	.94 (.90)
Self Knowledge	.36 (.70)	1.04 (.93)	1.10 (.83)	.84 (.90)
False Belief Tasks	.28 (.68)	.96 (.89)	1.25 (.85)	.80 (.89)
I-Necessity				
Common Sense	.92 (.81)	1.60 (.76)	1.65 (.75)	1.37 (.84)
Self Knowledge	1.04 (.93)	1.68 (.69)	1.65 (.75)	1.44 (.85)
False Belief Tasks	1.00 (.86)	1.80 (.58)	1.65 (.75)	1.47 (.81)
I-Intention				

Common Sense	1.08 (.86)	1.64 (.70)	1.50 (.83)	1.40 (.82)
Self Knowledge	1.16 (.94)	1.56 (.77)	1.70 (.73)	1.46 (.85)
False Belief Tasks	1.08 (.86)	1.72 (.68)	1.65 (.75)	1.47 (.81)
FB-Necessity				
Common Sense	1.00 (.91)	1.68 (.69)	1.60 (.75)	1.41 (.84)
Self Knowledge	.92 (.91)	1.76 (.60)	1.60 (.75)	1.41 (.84)
False Belief Tasks	.84 (.90)	1.72 (.68)	1.60 (.75)	1.37 (.87)
FB-Intention				
Common Sense	.92 (.81)	.36 (.70)	.45 (.83)	.59 (.80)
Self-knowledge	.96 (.84)	.28 (.61)	.35 (.67)	.54 (.77)
False belief tasks	1.08 (.91)	.24 (.66)	.45 (.76)	.60 (.86)

Note. *Note*. Values in parentheses are standard deviations;

n = 25 for Age 4; *n* = 25 for Age 5; and *n* = 20 for Age 6;

N = 70.

The six learning tasks involved three types of learning contents: common sense, self knowledge, and classic false beliefs. Table 8.1 shows the means of single *Necessity* and *Intention* predictions by age in Study 5. K-Necessity and K-Intention stand for *Necessity* and *Intention* of the knowledgeable person; I-Necessity and I-Intention stand for *Necessity* and *Intention* of the ignorant person; and FB-Necessity and FB-Intention stand for *Necessity* and *Intention* of the person with false belief. Overall, children's responses were not significantly different among the three types of learning contents. Paired t-tests between any two content domains did not find any significant difference. The result suggested that children's difficulty with the learning prediction questions found in Study 1, 2, and 4 were a persistent phenomenon across learning domains. Children answered the learning prediction questions consistently no matter whether it was a simple fact learning task, or obvious self knowledge. The same was found when children were asked to predict the characters' learning necessity and learning intention in classic false belief tasks.

8.5.2. Single Prediction Questions

Since there were no significant differences among the three learning contents, children's responses on each item across the 6 tasks were summed up in the following analyses. For consistency, average percentages of correct responses to the learning *Necessity* of different knowledge states by age are displayed in Figure 8.1, instead of presenting the sum of six tasks. There were significant age differences on all three questions, $F(2, 67) = 18.00$, $p < .000$ for K-Necessity; $F(2, 67) = 7.51$, $p < .000$ for I-Necessity; and $F(2, 67) = 8.73$, $p < .000$ for FB-Necessity. Post-hoc comparisons found significant differences between 4 and 5 years, but not between 5 and 6 years, on all three items. The 6-year-olds did equally well on three questions. The mean for K-Necessity was significantly lower than that of I-Necessity, $t(69) = -3.87$, $p < .000$; also lower than FB-Necessity, $t(69) = -3.45$, $p = .001$. There was no significant difference between I-Necessity and FB-Necessity, $t(69) = -.28$, $p = .782$. Again, children, especially younger children, tended to give positive feedbacks to the *Necessity* questions. This result replicated what was found in Study 4.

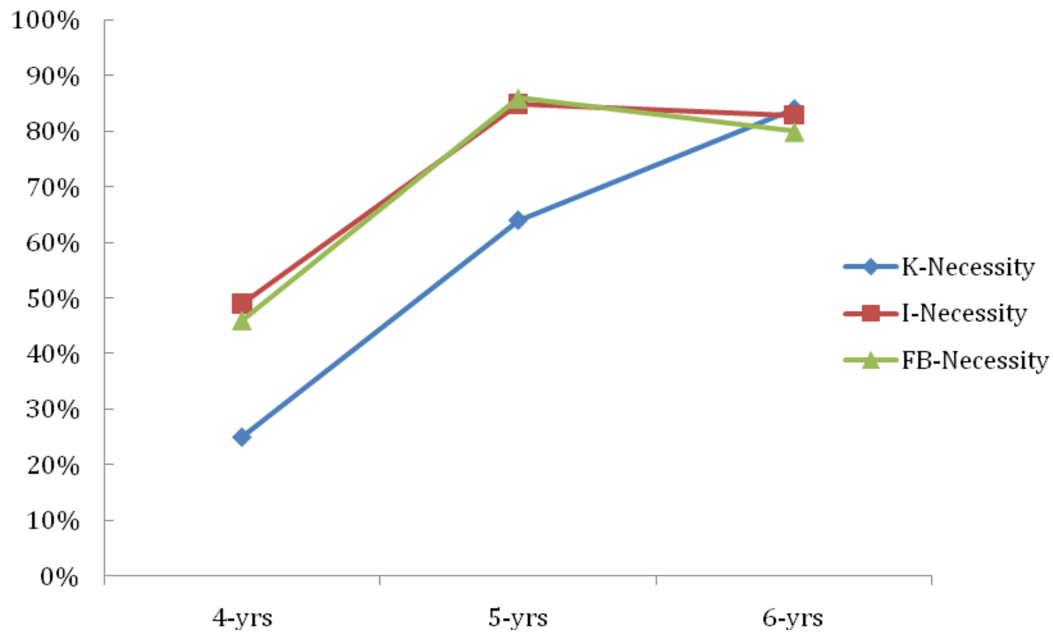

Figure 8.1. Average percentage of correct responses by age for Necessity questions in Study 5.

Figure 8.2 shows the average percentages of learning *Intention* of different knowledge states across age. K-Intention stands for *Intention* of the knowledgeable person; I-Intention stands for *Intention* of the ignorant person; and FB-Intention stands for *Intention* of the person with false belief. There were significant age differences in all three questions, $F(2, 67) = 10.64$, $p < .000$ for K-Intention; $F(2, 67) = 4.31$, $p = .017$ for I-Intention; and $F(2, 67) = 6.73$, $p = .002$ for FB-Intention. Only for FB-Intention, the performance dropped with the increase of age. Again, post-hoc comparisons found significant differences between 4 and 5 years, but not between 5 and 6 years, in all three items. Children did better on the *Yes* item than on the *No* items. The mean for I-Intention was significantly higher than that of K-Intention, $t(69) = 5.69$, $p < .000$; also higher than FB-Intention, $t(69) = 4.92$, $p < .000$. This result again suggested children tended to give positive responses to learning prediction questions.

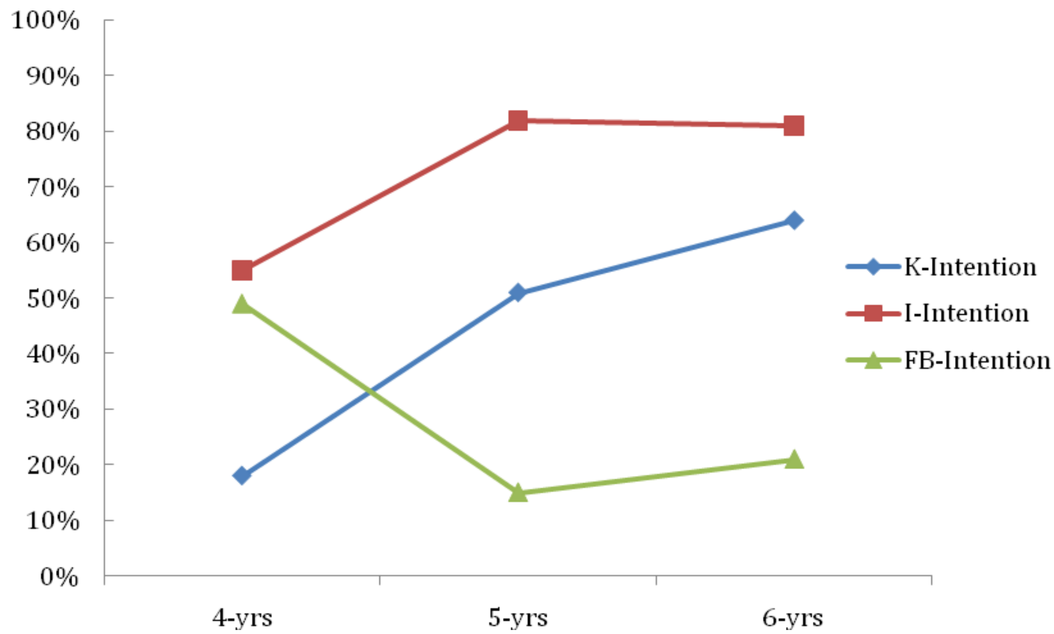

Figure 8.2. Average percentage of correct responses by age for Intention questions in Study 5.

Children's performance on FB-Intention was closer to that on K-Intention than that on I-Intention. However, the development of FB-Intention went in the opposite direction from that of K-Intention and I-Intention in Figure 8.2. Note the *Yes* answer was correct for I-Intention but wrong for FB-Intention. The 4-year-olds answered both the I-Intention and FB-Intention at random level. With the increase in age, more and more children responded that the person with false belief would try to learn, just like the ignorant person. The two lines representing I-Intention and FB-Intention formed an almost perfect mirror image of each other. It seemed children based their *Intention* judgment in FB-Intention on the character's knowledge state, rather than the belief about his or her own knowledge state. False belief as the basis for learning *Intention* did not enter the horizon even for the 6-year-olds.

Comparing children's performances on *Necessity* with that on *Intention*, they did better on knowledge based *Necessity* questions than belief based *Intention* questions, except for I-Necessity and I-Intention. There were significant difference between K-Necessity and K-Intention, $t(69) = 4.08$, $p < .000$; as well as between FB-Necessity and FB-Intention, $t(69) = 4.53$, $p < .000$. The difference between I-Necessity and I-Intention was not significant, $t(69) = -.49$, $p = .625$.

8.5.3. Forced Choice Prediction Questions

Children's responses on the forced choice questions were not significantly different across three content domains either. The sums of responses across three domains were used in the following analyses. Figure 8.3 shows the average percentages of *Intention* and *Necessity* forced choice questions across three age groups. There were significant age differences in K/I-Necessity, $F(2, 67) = 11.54$, $p < .000$; in K/FB-Necessity, $F(2, 67) = 11.13$, $p < .000$; and in K/I-Intention, $F(2, 67) = 5.65$, $p = .005$, but not in FB/I-Intention, $F(2, 67) = .35$, $p = .706$.

It was easier for children to judge who would need to learn between the knowledgeable person and the person with false belief (K/FB-Necessity) than between the knowledgeable person and the ignorant person (K/I-Necessity), $t(69) = -2.39$, $p = .020$. It was also easier to judge who would try to learn between the knowledgeable person and the ignorant person (K/I-Intention) than between the ignorant person and the one with false belief (FB/I-Intention), $t(69) = 5.37$, $p < .000$. Even 6-year-olds found it especially challenging when they had to decide between the ignorant person and the one with false belief, who would try to learn. Children's performances on *Necessity* and *Intention* did not differ significantly between K/I-Necessity and K/I-Intention, $t(69) = -1.68$, $p = .098$.

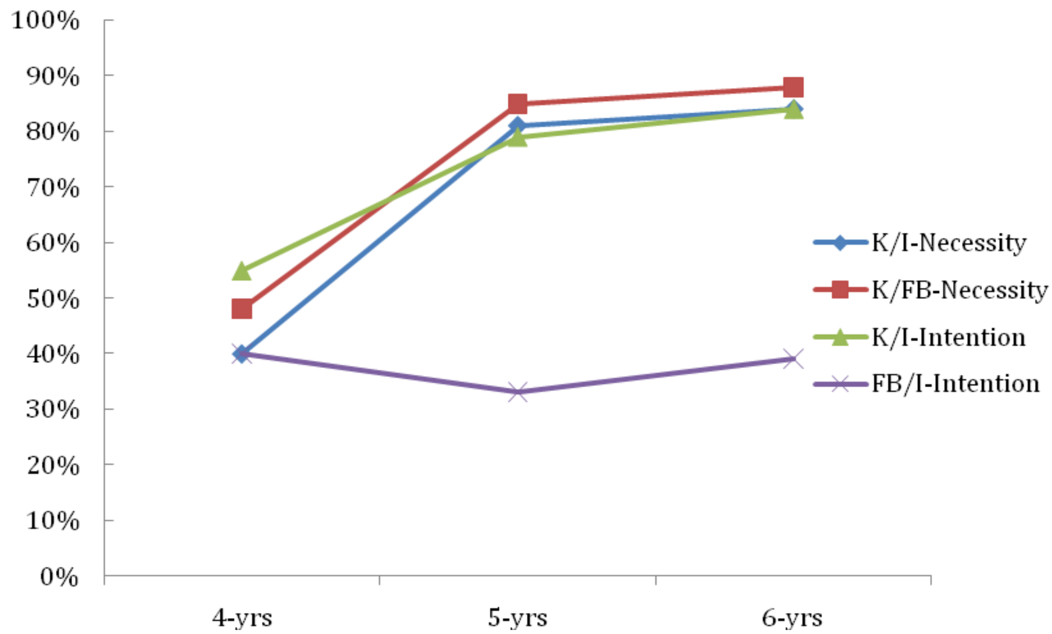

Figure 8.3. Average percentage of correct responses by age for Intention and Necessity forced choice questions in Study 5.

8.5.4 Correlation between Intention / Necessity and ToM

Table 8.2 lists correlations between ToM indicators and learning *Intention* and *Necessity* predictions in the forced choice questions. Except for FB/I-Intention, all learning prediction questions were correlated with ToM scale score and the sum of *Contents FB* and *Knowledge Access*. Even after controlling for age, the sum of *Contents FB* and *Knowledge Access* was still significantly correlated with learning predictions, except for FB/I-Intention.

Table 8.2

Correlations between ToM indicators and forced choice Intention / Necessity predictions in Study 5.

	ToM	False Belief	Contents FB and Knowledge Access
Zero-order correlation(df = 68)			
K/I-Necessity	.31**	.26*	.50***
	(.009)	(.029)	(.000)
K/FB-Necessity	.31**	.23	.44***
	(.009)	(.057)	(.000)
K/I-Intention	.29*	.21	.37**
	(.015)	(.083)	(.002)
FB/I-Intention	-.040	-.13	-.19
	(.742)	(.287)	(.111)
Controlling for age (df = 67)			
K/I-Necessity	.15	.06	.36**
	(.227)	(.643)	(.003)
K/FB-Necessity	.15	.02	.28*
	(.219)	(.884)	(.022)
K/I-Intention	.17	.05	.24*
	(.176)	(.708)	(.046)
FB/I-Intention	-.04	-.14	-.21
	(.770)	(.257)	(.083)

Note. Cells contain Pearson correlations. Numbers in parentheses are *p* values;

*: $p < .05$;

**: $p < .01$;

***: $p < .001$.

8.6 Discussion

Children's overwhelmingly positive learning prediction was not an artifact of the learning contents. Even with the most obvious knowledge, such as one's own name and sex, children were still prone to predict one would need to learn, and one would try to learn. The same phenomenon persisted in the classic false belief scenarios. The same happened when comparing different knowledge and belief states; children did not distinguish false belief from ignorance in all three conditions. The result pinpointed the inherent knowledge and belief components in classic false belief tasks that directly bridge the false belief understanding with *mindful learning*.

In single prediction questions, children, especially younger children, tended to give positive feedback to both *Necessity* and *Intention* questions. This result replicated what was found in Study 4. However, in forced choice questions, with the increase of age, children systematically picked out who would need to learn and who would try to learn, except for the intention prediction between the ignorant person and the one with a false belief. It is clear that the older children were not unanimously giving positive answers to learning predictions; they did appreciate the role of knowledge state and belief in learning to a certain extent.

The most interesting finding of Study 5 was that it was especially challenging for children to decide between the ignorant person and the one with false belief, who would try to learn (FB/I-Intention). Even 6-year-olds performed at random level. According to the response pattern of single predictions on learning intention, children seemed to treat FB-Intention the same way they did with I-Intention. False belief has two layers of information: first, the person who has a false belief does not have the correct knowledge. From this perspective, false belief is indeed similar to ignorance. It was even easier for children to judge who would need to learn between the knowledgeable person and the person with false belief than between the knowledgeable person and the ignorant person, probably because the idiosyncrasies of the false beliefs made the contrast between knowledge and ridiculous false belief more salient for children, which provoked their thinking in knowledge based learning prediction. In fact, some children laughed at or commented on the silliness of the character's false belief while listening to the stories.

However, false belief has more connotation than ignorance in terms of the actuality of belief. It seemed this was what children could not grasp. Children's random pick between the ignorant person and the one with false belief in learning intention prediction and the large gap between K/I-intention and FB/I-Intention revealed a premature belief understanding. The results suggested that it was easier for children to understand the implications of true belief about knowledge state in learning than that of false belief.

ToM indicators including general ToM ability as measured by the ToM scale and the sum of *Contents FB* and *Knowledge Access* correlated both with *Necessity* and *Intention* questions, except for FB/I-Intention. The sum of *Contents FB* and *Knowledge Access* as a measure of belief understanding correlated with *Necessity* and *Intention* questions even after controlling for age, except for FB/I-Intention. This result was different from the one found in Study 4 that only *Intention* was correlated with ToM indicators. Both *Intention* and *Necessity* are based on the understanding of epistemological mental processes in learning. It makes sense that once the *Yes* bias was controlled, both were correlated with ToM. FB/I-Intention was not correlated with any of the ToM indicators, probably due to limited variance. Even for 6-year-olds in the current sample, learning intention based on false belief was still a very challenging concept.

8.7 General Discussion for Study 4 and 5

Studies 4 and 5 provided insight into children's understanding of the role of belief in learning. Children had no problem with true beliefs in learning. However, they found the effect of false belief in learning more difficult to comprehend. In terms of learning predictions, it was hypothesized that children need to understand that the learner's actual knowledge decides whether it is necessary to learn; but it is the learner's belief about one's own knowledge instead of the actual knowledge that determines whether one would try to learn. Study 4 found that children seemed to treat the intention questions the same way as they did with the necessity questions, even in false belief stories. They tended to answer both questions with *Yes.* In Study 5, however, children showed different response patterns between learning *Necessity* and *Intention* after controlling the *Yes* bias, especially between the *Necessity* questions and the FB/I-Intention. Children found knowledge based *Necessity* questions easier than belief based *Intention* questions.

When the tasks involved a false belief in Study 4, children tended to reprocess belief according to the actual knowledge states. In Study 5, when children had to choose who would try to learn between an ignorant person and a person with false belief, even the oldest children could not differentiate false belief from ignorance and so chose randomly. Evidence suggested that children at this age had a great difficulty with learning tasks with false belief. Correlations with ToM indicators, especially with belief understanding measured by the sum of *Contents FB* and *Knowledge Access* in both studies, supported this finding. False belief as the most significant indicator of ToM development is also the most relevant factor in *mindful learning*.

The idiosyncrasies of false belief in learning tasks did facilitate understanding of *mindful learning* even though children did not fully understand the epistemological consequences of false belief. In Study 4, children did better in learning intention prediction with false belief than that with positive knowledge and belief, after adjusting the prediction according to their belief understanding. In study 5, children did systematically better in learning necessity prediction between the knowledgeable person and the ignorant person than that between the knowledgeable person and the person with a false belief. By making the contrast between different types of knowledge states more salient, teachers might be able to help children come to understand the distinction between knowledge and (false) belief and therefore become closer to mindful learners.

CHAPTER NINE

Study 6: Learning Intention

Study 6 examines children's understanding of the importance of learning intention. Knowledge change is a necessary and sufficient condition for recognizing learning. Intention, on the other hand, is neither, even though it plays an important role in learning. Intention is necessary when people begin to control their own learning. However, learning takes place as long as there is genuine knowledge change, no matter whether it is intentional learning or accidental discovery. Even with the presence of a learning intention, learning might still fail due to various reasons, such as task difficulty. This study explores how young children understand the complex mechanism of intention involved in the process of learning, especially when there is a conflict between the learning intention and learning outcome.

9.1 Design

Six intention stories were designed for this study. They involved three levels of learning intention: positive intention, negative intention, and intention of resistance; as well as two levels of learning outcome: positive outcome and negative outcome. The tasks with an intentional state that was consistent with the learning outcome were rather straightforward. The learner either intended to learn and eventually learned (*Positive Intention - Learning, or* PI-L); or did not intend to learn, or intended not to learn, and ended up not learning (*Negative Intention - No Learning*, or NI-NL; and *Resistance - No Learning,* or R-NL). The tasks with an intentional state that was inconsistent with the learning outcome may be less straightforward but were still reasonable. The *Positive Intention - No learning* task, or PI-NL, resembled the *Failed Learning* task in Study 1, with an emphasis on the learning intention. Similarly, *Negative Intention - Learning* task, or NI-L, was an enhanced version of the *Discovery* task in Study 2, with elaboration of (the absence of) intention. The *Resistance - Learning* task, or R-L, was an implicit learning story. This type of events occurs when learning takes place in spite of a resistant intention, such as one hates a song yet somehow begins to hum the melody after overhearing it. Control questions about the knowledge state were asked twice, both before and after the learning event. Two task questions were asked at the end of each story addressing the learning intention and the learning outcome. For a summary of the task specifications of Study 6, see Table 9.1.

Table 9.1

Task specifications of Study 6

	Learning intention	Learning outcome	Did the character try to learn?	Did the character learn?
PI-L	+	+	Yes	Yes
PI-NL	+	-	Yes	No
NI-L	-	+	No	Yes
NI-NL	-	-	No	No
R-L	--	+	Try not to	Yes
R-NL	--	-	Try not to	No

The learning content of the NI-L task needed to be something that the learner could pick up intuitively without a learning intention. The story was designed in a way that the learner accidentally mixed two colors and came up with a third color. The learning content of R-L had to be something one could learn implicitly, such as learning to sing a song. Because of the restrictions on these two tasks, the learning contents could not be fully counterbalanced. To block the potential effect of the content to a maximum level, a quasi rotation was adopted using Latin Square design with the other 4 stories. That means each one fourth of the participants shared a common content in each of the other 4 stories. Meanwhile, all participants shared the same contents in NI-L and R-L.

For examples of the stories, see Appendix G. An example of the NI-L story reads like this:

> Can you make green paint using other colors?
> This is Quincy. Quincy cannot make green paint. He just can’t.
> Can Quincy make green paint?
> Today in school, Quincy drops some blue paint in yellow paint by accident while painting. Oops! Look what happened. The two colors make green. “So that’s how you make green paint,” Quincy says. Then Teletubby asks Quincy: "Can you make green paint?" Quincy says: "Yes, I can. I can mix yellow paint and blue paint together and make green." Quincy can make green paint.
> Can Quincy make green paint?
> Did Quincy try to learn how to make green paint?
> Did Quincy learn how to make green paint today?

9.2 Participants

Seventy-two children with informed consent were recruited for this study from the same sample pool as Study 1, 2 and 4 from CQ. These children did not participate in any of the previous studies. Their age ranged from 40 months to 90 months (M = 66.87, SD = 11.83), including 31 girls and 41 boys. There were 24 4-year-olds from 40 to 60 months (M = 54.08, SD = 3.99), including 10 girls and 14 boys; 24 5-year-olds from 61 to 71 months (M = 65.50, SD = 2.99), including 11 girls and 13 boys; and 24 6- and young 7-year-olds from 72 to 90 months (M = 81.04, SD = 5.75), including 10 girls and 14 boys.

9.3 Materials

In addition to Teletubby and Lego figurines, more props were used in demonstrating the learning scenarios in the stories, including a cardboard clock model with a short arm and a long arm attached to the dial by thread; a colored picture of a rainbow; a black and white line drawing of the hand gestures of Rock-Paper-Scissors arranged in a triangle connected with arrows pointing to subordinate gesture; small bottles of yellow and blue paint and brushes; a stack of 8” by 4.5” paper for folding paper planes; and a colored picture of a birthday party scene.

9.4 Procedures

The experimenter began by asking the participant to perform the tasks in the learning stories. If the child could not perform the task, the experimenter demonstrated with props. For example, in the clock reading task, the experimenter gave an example and told the child, “When the short arm points to 3, and the long arm points to 12, it is 3 o’clock.” Then the child was introduced to the characters represented by figurines. The learning tasks were acted out with props, including turning the arms on the clock model, elaborating the rule of Rock-Paper-Scissors, enumerating colors on the rainbow picture, mixing colors with paint and brush, folding a paper plane, and singing the *Happy Birthday* song to the birthday picture. The learning intention was demonstrated by manipulating the figurines’ position and gesture. For example, when the character was paying attention, the experimenter moved the figurine closer to the scene and leaned forward towards the prop. When the character was not paying attention, the figurine sat down facing opposite direction from the learning scene. In the case of *Resistance,* the experimenter covered the figurines’ eyes and/or ears.

The six learning tasks were presented in random order. Each child finished the ToM battery and the learning tasks in one session of about 20 minutes. The ToM battery and the intention tasks were presented in a random order.

9.5 Results

Seven children answered at least one of the knowledge control questions incorrectly. Their responses on that story were excluded from the analyses. There were 10 “don’t know” responses, 8 in intention judgments, and 2 in learning. The “don’t know” responses were treated as incorrect answers. Mann - Whitney U tests established that boys’ and girls’ performances did not differ significantly.

9.5.1 Intention

The percentage of correct responses on the six intention questions differed significantly from each other, Cochran’s $Q = 68.13$, $df = 5$, $N = 66$, $p < .000$. Figure 9.1 shows that the tasks without conflict between intention and outcome, such as PI-L-Intention, NI-NL-Intention, and R-NL-Intention, were easier than those with conflict for children, especially for older children. The pattern of differentiation between non-conflict tasks and conflict tasks was consistent across tasks with *Yes* answers, *No* answers, or forced choice answers. Percentage of correct responses on PI-L-Intention was significantly higher than that on PI-NL-Intention, exact test’s $p = .003$, $N = 68$. Percentage on NI-NL-Intention was significantly higher than that on NI-L-Intention, $\chi^2(1, N = 70) = 26.69$, $p < .000$. And percentage on R-NL-Intention was significantly higher than that on R-NL-Intention, $\chi^2(1, N = 71) = 20.10$, $p < .000$.

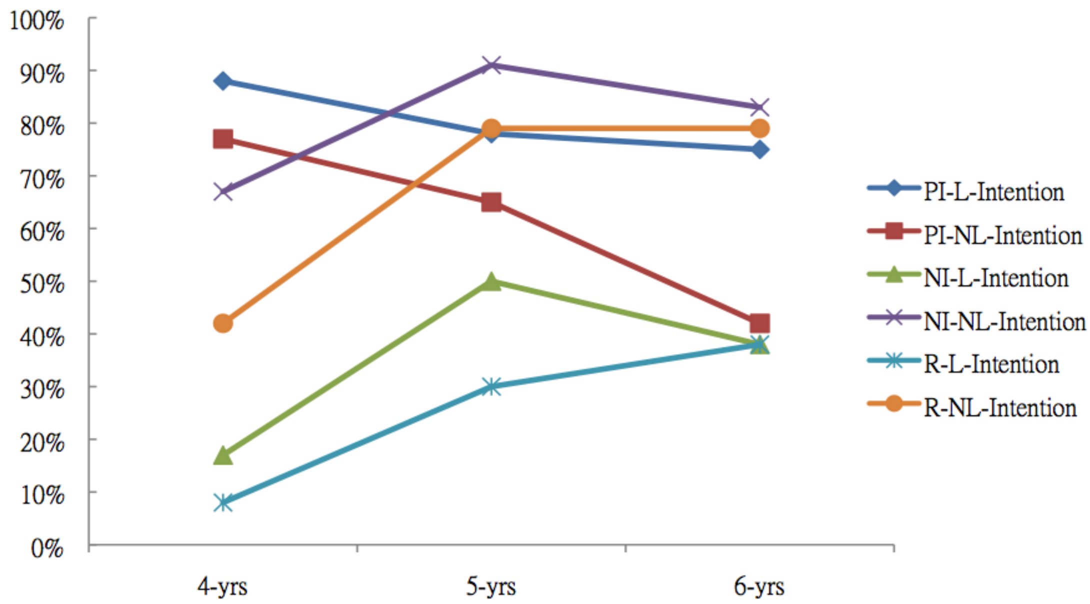

Figure 9.1. Percentage of correct responses by age for Intention questions in Study 6.

Children's performances on the intention questions generally improved with age, except for PI-L-Intention and PI-NL-Intention, in which the PI-NL-Intention showed significant decrease with age, $\chi^2 = 6.26$, $df = 2$, $p = .043$. Notice that the correct answers to these two intention questions were the only positive answers out of the 6 intention questions. It seemed that younger children were affected by the *Yes* bias; they tended to answer the intention questions with "Yes," which happened to be the right answer for PI-L-Intention and PI-NL-Intention. Older children, however, tended to consider the learning intention in the story context and adjusted their intention judgment based on the learning outcome. Six-year-olds, but not younger children, did significantly worse on PI-NL-Intention than on PI-L-Intention, exact $p = .021$, $n = 24$. When the character intended to learn but somehow did not learn, 6-year-olds were more likely to conclude that the character did not try to learn.

9.5.2 Learning

The learning outcomes were stated explicitly at the end of the stories. As shown in Figure 9.2, all children answered correctly to the learning questions in tasks with positive learning outcomes. This result replicated that of SL in Study 1, showing young children did understand the change from not knowing to knowing was learning. However, the same children did poorly in tasks with negative learning outcomes. Children's performances on the six learning questions differed significantly from each other, Cochran's $Q = 81.72$, $N = 66$, $df = 5$, $p < .000$. Again, a *Yes* bias was present here.

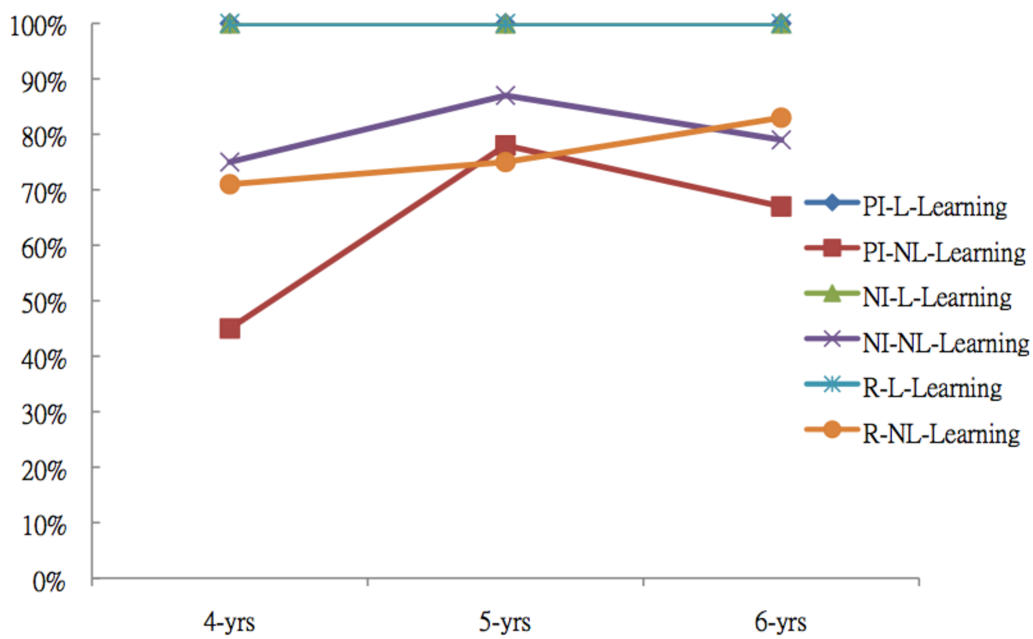

Figure 9.2. Percentage of correct responses by age for Learning questions in Study 6.

Out of the three tasks with negative learning outcomes, PI-NL was the only conflict task. Children did significantly better on non-conflict tasks than on conflict task: NI-NL-Learning was better than on PI-NL-Learning, exact test's $p = .004$, $N = 69$; R-NL-Learning was better than on PI-NL-Learning, exact test's $p = .031$, $N = 69$. There was no statistically significant difference between the two non-conflict tasks, exact test's $p = .754$, $N = 71$.

9.5.3 Relation between Learning and Intention

Table 9.2 shows that children did significantly better on learning than on intention judgment in stories with positive learning outcomes, but no difference between learning judgment and intention judgment in tasks with negative learning outcomes. The fact that children did well on the positive learning judgment in both conflict and non-conflict tasks suggested that children could make learning judgment based solely on physical cues independent of intention.

Table 9.2

Differences between Learning and Intention questions in Study 6[1]

	PI-L	PI-NL	NI-L	NI-NL	R-L	R-NL
N	71	69	71	71	71	72
$\chi 2$		.03	44.02		51.02	
Asymp. Sig.		.868	.000		.000	
Exact sig.[2] (2-tailed)	.000			1.000		.167

Note. 1. McNemar Test

2. Binominal distribution used

The intention judgment, on the other hand, was mostly influenced by the learning outcome. As shown in Table 9.3, in PI-NL task, other than those who answered both questions correctly, only 8 children in total answered both learning and intention questions incorrectly. The majority of mistakes fell into 2 categories: the character either intended to learn and learned (17 cases in total), or did not intent to learn and failed (19 cases in total). It suggested that children to some extent did realize that intention played an important role in learning process; they understood that positive intention was usually associated with positive outcome, and vice versa.

Table 9.3

Crosstabulation of PI-NL Learning and Intention questions by age in Study 6

Age			PI-NL-Learning		
			0	1	Total
4	PI-NL-Intention	0	4	1	5
		1	8	9	17
		Total	12	10	22
5	PI-NL-Intention	0	2	6	8
		1	3	12	15
		Total	5	18	23
6	PI-NL-Intention	0	2	12	14
		1	6	4	10
		Total	8	16	24
Total	PI-NL-Intention	0	8	19	27
		1	17	25	42
		Total	25	44	69

Note. N = 69.

9.5.4 Correlation between Learning / Intention and ToM

Table 9.4 lists correlations between ToM indicators and children's responses to the intention and learning outcome questions. Both intention and learning outcome were significantly correlated with ToM scale score, false belief, and the sum of *Contents FB* and *Knowledge Access*. Correlations mostly stayed significant after controlling for age. Children's understanding of the mechanism of intention in learning was strongly correlated with their mental state understanding.

Table 9.4

Correlations between ToM indicators and Learning / Intention questions in Study 6

	ToM	False Belief	Contents FB and Knowledge Access
Zero-order correlation(df = 64)			
Intention	.30*	.38**	.40**
	(.016)	(.002)	(.001)
Learning	.29*	.28*	.33**
	(.017)	(.025)	(.006)
Controlling for age (df = 63)			
Intention	.20	.32*	.33**
	(.111)	(.010)	(.008)
Learning	.26*	.24	.31*
	(.038)	(.054)	(.011)

Note. Cells contain Pearson correlations. Numbers in parentheses are *p* values;

*: $p < .05$;

**: $p < .01$;

***: $p < .001$.

9.6 Discussion

In her thesis on intentional bias, Rosset (2008) argued that human actions are assumed intentional until proven otherwise. People tend to impose an intention on accidents as a causal explanation. The focus of intention understanding is not how to infer intention, but how to inhibit it. This is what happened in the tasks of NI-L and R-L in the current study, where the learner picked up the knowledge or skill through accident or implicit learning without a learning intention. These two tasks were the most difficult ones, as shown in Figure 9.1, indicating children’s difficulty of inhibiting the assignment of a learning intention.

However, this is not the whole story. The negative intention tasks NI-NL and R-NL were quite easy for children. The challenge in Study 6 was presented by tasks with a conflict. When the learning intention was congruent with the learning outcome, children could use their understanding of knowledge state change to help them answer both the learning question and the intention question. When the learning intention was incongruent with the outcome, the same strategy would only lead to mistaken modification of intention judgment based on the learning outcome. Note that only those who understood the causal effect of intention would adjust their intention judgment to try to explain the unexpected learning outcome, even though it was an inaccurate and incomplete explanation. Younger children who were yet to develop a causal understanding of intention might even answer the intention question correctly based on behavioral cues (whether the character was paying attention to the learning event), without realizing there might be a connection of some sort between the learning intention and the learning outcome whatsoever, such as what happened in PI-NL.

Children had a hard time accepting positive intention could lead to negative outcome. “You are lying,” one 5-year-old boy commented on the story of PI-NL, “how come he did not learn if he had tried very hard to?” Overall, children adjusted the intention judgment to accommodate the simple cause-effect explanation of the relation between intention and outcome. In stories with negative learning outcomes like PI-NL, more children got the learning correct and the intention incorrect with the increase of age (1 in 4-year-olds, 6 in 5-year-olds, and 12 in 6-year-olds, see Table 9.4). It seemed younger children answered the intention question in PI-NL correctly simply because of the influence of *Yes* bias.

With the increase of age, children began to take both intention and the learning outcome into consideration simultaneously, and favored the learning outcome by adjusting the intention judgment to meet the simple causal framework. Children developed an understanding of learning outcome first; then incorporated the learning intention in the causal relationship by treating the learning intention and outcome as a bundled unit and used a simple cause-effect relation to make sense of the learning event. As far as the current sample is concerned, 6-year-olds did not yet understand the complex mechanism of intention in the process of learning. As shown in Figure 9.1, the 6-year-olds did well on intentional judgment in non-conflict stories, but responded at random in conflict stories, exact p = .541 for PI-NL, exact p = .3.07 for NI-L, and exact p = .307 for R-L.

Even though intention is not a sufficient or necessary condition for learning, it is nevertheless an important component in *mindful learning*. Children's understanding of the mechanism of intention in learning was strongly correlated with their mental state understanding.

Mills and Keil (2004) argued that overestimating one's own knowledge and ability has adaptive advantages because it gives children a positive self-concept and protects them from getting hurt knowing they are incompetent in so many areas. Following that logic, over-attributing learning is also adaptively meaningful, in that it gives children a (false) sense of control in their own learning. As an intentional stance is the default in action explanation (Dennett, 1987; Rosset; 2008), children readily impose intention in pure discovery and implicit learning to claim credit; and discard intention in failed learning to stay clear of liability.

In summary, Study 6 replicated Study 1 in finding that children over-attributed learning in failed learning events. More importantly, this study found that children had trouble with learning scenarios that presented a conflict between the learning intention and outcome. They adjusted the intention judgment to keep in line with the learning outcome. Both children's intention judgment and learning judgment were correlated with mental state understanding.

CHAPTER TEN

Theory of Mind Scaling

10.1 Sample Descriptions

Total of 198 participants in Study 1, 2, 4, 6 from CQ and 75 participants in Study 3 and 5 from HK participated in the ToM measure using Wellman and Liu's ToM Scale (2004). Table 10.1 shows the demographic information of the CQ sample and the HK sample, and the means and standard deviations of the sum of 6 or 5 items in the ToM scale. The two samples shared similar makeup.

Table 10.1

Chong Qing (CQ) and Hong Kong (HK) sample's descriptions

	Age 4		Age 5		Age 6		Total	
	CQ	HK	CQ	HK	CQ	HK	CQ	HK
N	52	25	72	25	74	25	198	75
Boys/girls	29/23	14/11	42/30	13/12	44/30	12/13	115/83	40/35
Mean age	54.90	52.80	65.04	64.52	80.88	79.04	68.30	65.45
in months	(3.52)	(3.22)	(3.46)	(3.81)	(6.53)	(4.38)	(11.58)	(11.48)
Range in months	40-59	48-58	59-71	59-70	72-99	72-86	40-99	48-86
Mean of 5	2.54	2.68	3.01	3.04	3.74	3.88	3.16	3.20
items	(1.02)	(.99)	(1.16)	(1.21)	(1.11)	(.83)	(1.20)	(1.28)
M of 6	2.83	2.84	3.44	3.32	4.38	4.44	3.63	3.53
items	(1.22)	(1.18)	(1.45)	(1.41)	(1.42)	(1.19)	(1.51)	(1.42)

Note. Numbers in parentheses are standard deviations.

In addition to Wellman and Liu's (2004) test of the scale with children from Ann Arbor, Michigan of the United States, Wellman and colleagues (Peterson, et al., 2005; Peterson & Wellman, 2009; Wellman, et al., 2006) also examined scaling of ToM development in typical Chinese children and Australian children who were typical, deaf, or autistic using the same items. They found that typical Western children developed ToM understanding following the exact same sequential steps of *Diverse Desire*, *Diverse Belief*, *Knowledge Access*, *Contents False Belief*, and *Hidden Emotion.* Australian deaf children, especially late signing deaf children, replicated the same sequence, only with a developmental delay in time. Australian autistic children also developed ToM understanding later in life; however, they passed the emotion understanding earlier than false belief understanding, contrary to typical children and deaf children. Their test of the scale with children from Beijing surprisingly found that Chinese children passed *Knowledge Access* earlier than *Diverse Belief*, contrary to Western children. Table 10.2 compares the CQ sample and HK sample in the current study with Wellman and colleagues' Ann Arbor (AA) sample, Beijing (BJ) sample, and autistic children on the passing rates of each item in the ToM scale. Even though the CQ sample and HK sample were one year older than the AA sample and BJ sample, the passing rates for the four samples are similar. The autistic children in Peterson, et al. (2005) were older in chronological age with a mean of 9.32, and a verbal mental age above 4.00.

Out of the 198 participants from CQ, 105 were given the test using Order 1 suggested by Wellman, and 93 using Order 2. A preliminary Age(4) × Order(2) × Gender(2) analysis of variance on total of 5 tasks yielded a main effect of age, $F(3,182) = 12.56$, $p < .000$. No main effects were found for gender or order. The same was found in

HK sample, out of the 75 participants, 35 were given the test using Order 1 and the others using Order 2. Age(3) × Order(2) × Gender(2) analysis of variance on total of 5 tasks yielded a main effect of age, $F(2,63) = 7.57$, $p = .001$. No main effects were found for order or gender.

Table 10.2

Passing rates on ToM items from CQ and HK sample as well as other samples from the literature

	CQ	HK	AA	BJ	Autistic children
Diverse Desire	.94	.89	.95	.89	.86
Knowledge Access	.78	.83	.73	.79	.75
Diverse Belief	.56	.61	.84	.71	.86
Contents False Belief	.47	.33	.59	.54	.47
Explicit False Belief	.47	.35	.57	.49	N/A
Hidden Emotion	.40	.52	.32	.37	.64

10.2 Five-Item Guttman Scale

Wellman and Liu (2004) suggested that *Explicit False Belief* could be taken out of the scaling because this task and *Contents False Belief* shared the same difficulty level. The two tasks were roughly equal in passing rates in the CQ sample and the HK sample too. Therefore the current scaling only considered the 5 official items in the scale. The data from current samples found that, consistent with Wellman et al.'s (2006) study with the Chinese children, *Knowledge Access* was easier than *Diverse Belief* for both CQ and HK children. Another difference in the sequence found in this study was that for the HK sample, *Hidden Emotion* was easier than the false belief tasks, similar to what Peterson et al. (2005) found with autistic children. A closer examination of the CQ sample also found the difficulty levels of *Contents FB* and *Hidden Emotion* were reversed for 4-year-olds. Table 10.3 shows that for both the CQ sample and the HK sample, *Contents FB* was more difficult than *Hidden Emotion* for younger children, but easier for older children.

Table 10.3

Passing rates on Contents FB and Hidden Emotion by age in CQ and HK sample

	CQ		HK	
Age	*Contents FB*	*Hidden Emotion*	*Contents FB*	*Hidden Emotion*
4	.21	.38	.08	.52
5	.47	.31	.32	.44
6	.66	.51	.64	.60
Total	.47	.40	.35	.52

Pair-wise comparisons did not replicate Wellman and Liu's (2004) significant differences between any two consecutive items either. For the CQ sample, the difference between *Diverse Desire* and *Knowledge Access* was significant, $\chi^2(1, N = 198) = 20.89$, $p < .000$; the difference between *Knowledge Access* and *Diverse Belief* was also significant, $\chi^2(1, N = 198) = 23.90$, $p < .000$. However, the difference between *Diverse Belief* and *Contents False Belief* was not statistically significant, $\chi^2(1, N = 198) = 2.96$, $p = .085$; neither was the difference between *Contents FB* and *Hidden Emotion*, $\chi^2(1, N = 198) = 1.88$, $p = .171$. For the Hong Kong sample, there was no significant difference between *Diverse Desire* and *Knowledge Access*, exact test $p = .359$, N =75. A significant difference was found between *Knowledge Access* and *Diverse Belief*, $\chi^2(1, N = 75) = 7.50$, $p = .005$. No significant difference was found between *Diverse Belief* and *Hidden Emotion*, $\chi^2(1, N = 198) = 1.03$, $p = .310$. There was a significant difference between *Hidden Emotion* and *Contents FB*, $\chi^2(1, N = 198) = 4.97$, $p = .026$.

In line with the passing rate sequence shown in Table 10.2, the CQ sample yielded a significant correlation between age in months and the sum of 5 items, $r(198) = .47$, $p < .000$. Out of the 198 participants, 58% fit (n=114) this Guttman scale, 84 exhibited other patterns. Coefficient of reproducibility was .92 (values greater than .90 indicate scalable items). Green's index of consistency, a more conservative measure, was .23, lower than the significant level of .50, meaning the observed coefficient of reproducibility was no greater than chance.

Similar results were achieved in the HK sample. Putting *Hidden Emotion* in front of *Contents FB*, the HK sample yielded a significant correlation between age in months and the sum of 5 items, $r(75) = .40$, $p < .000$. Out of the 75 participants, 56% fit (n=42) this Guttman scale, 33 exhibited other patterns. Coefficient of reproducibility was .91, and Green's index of consistency was .17, again, lower than the significant level of .50.

Since *Hidden Emotion* was the item behaving differently in the two samples, scalability indexes were computed again with this item removed. For the CQ sample, the scale with the remaining 4 items had 72 Guttman errors, a coefficient of reproducibility of .93, and coefficient of scalability of .27. For the HK sample, the remaining 4 items formed a scale with 33 errors, a coefficient of reproducibility of .91, and coefficient of scalability of .16. Deleting *Hidden Emotion* did not improve the scalability of the scale.

In Wellman and colleagues' BJ sample, they found the same sequence of the 5 items as that in the current CQ sample. Similarly, they reported a coefficient of reproducibility of .93, and coefficient of scalability of .25, lower than .50. Between their BJ sample and AA sample, *Diverse Belief* was the item that was discrepant. They computed the indexes without *Diverse Belief*, and found coefficient of reproducibility increased to .96, and coefficient of scalability increased to .50. Excluding *Diverse Belief* in the current study, the remaining 4 items in the CQ sample formed a scale with 51 Guttman errors, a coefficient of reproducibility of .95, and coefficient of scalability of .33; and the 4 items in the HK sample formed a scale with 16 Guttman errors, a coefficient of reproducibility of .95, and a coefficient of scalability of .43. The coefficients of scalability improved, but still did not achieve .50.

10.3 Five-Item Rasch Model

Guttman scaling is stringent and determinate because it requires the pattern to fit the scale exactly. The contemporary Rasch approach (Rasch, 1960; Wright & Masters, 1982) uses probability instead of exact fit in scale progression. Rasch analyses attain optimal scale sequence, fit statistics, and estimation of distance between items. Computer software WINSTEPS (Linacre, 2003) was used to conduct Rasch analyses of the five items in both CQ and HK sample.

Rasch modeling confirmed the sequence obtained by Guttman scaling from both samples. Table 10.4 shows item and person measure summary and fit statistics for 5-item Rasch model in the CQ sample. Fit statistics provide information on the extent to which the derived scale fit the data. Standardized infit and outfit indices less than 2.0 are considered acceptable. Out of the five items, *Hidden Emotion* did not fit the scale well in the CQ sample. Item difficulty of *Contents FB* was anchored at 5 for the convenience of comparing distances between items as well as comparing with other samples. The distances between any two consecutive items in terms of their difficulty levels were reasonably dispersed.

Table 10.4

Item and person measure summary and fit statistics for 5-item Rasch model in CQ sample

	Measure	Error	Infit		Outfit	
			MNSQ	ZSTD	MNSQ	ZSTD
Item difficulty summary and fit statistics						
Hidden Emotion	5.49	.19	1.30	3.4	1.56	2.2
Contents FB	5.00	.18	.80	-2.8	.70	-2.1
Diverse Belief	4.50	.18	1.02	.2	1.09	.6
Knowledge Access	2.90	.21	.78	-2.2	.59	-2.5
Diverse Desire	0.86	.33	.108	.3	1.72	.9
M	3.75	.22	1.00	-.2	1.13	-.2
SD	1.69	.06	.19	2.2	.45	1.8
Person ability summary and fit statistics (based on 168 non-extreme cases)						
M	4.29	1.19	.98	.0	1.01	.2
SD	1.35	.11	.63	.9	1.56	.8

Note. Expected values for standardized infit and standardized outfit is a mean of 0 and standard deviation of 1.0; fit statistics > 2.0 indicate misfit.

Note. N = 198.

Table 10.5 shows item and person measure summary and fit statistics for 5-item Rasch model in the HK sample. Fit statistics suggests the scale fit the data well and the sequence was considered stable and scalable. Again, item difficulty of *Contents FB* was anchored at 5. The distances between any two consecutive items in terms of their difficulty levels were reasonably dispersed.

Table 10.5

Item and person measure summary and fit statistics for 5-item Rasch model in HK sample

	Measure	Error	Infit		Outfit	
			MNSQ	ZSTD	MNSQ	ZSTD
Item difficulty summary and fit statistics						
Contents FB	5.00	.31	.89	-.5	.82	-.5
Hidden Emotion	3.92	.28	.89	-.9	.85	-.9
Diverse Belief	3.36	.28	1.07	.6	1.10	.6
Knowledge Access	1.85	.35	.87	-.2	.89	-.2
Diverse Desire	1.11	.43	1.31	1.1	1.77	1.3
M	3.05	.33	1.01	-.1	1.08	.1
SD	1.41	.05	.17	.8	.36	.8
Person ability summary and fit statistics (based on 65 non-extreme cases)						
M	3.69	1.16	.98	.0	1.08	.1
SD	1.13	.07	.57	1.0	1.46	.9

Note. Expected values for standardized infit and standardized outfit is a mean of 0 and standard deviation of 1.0; fit statistics > 2.0 indicate misfit.

Note. N = 75.

Table 10.6 compares item measures across the 4 samples. The sequence of CQ sample was exactly the same as that of Wellman and colleagues' BJ sample, with similar distances between items. The HK sample in this study, however, revealed a rather different developmental pattern with *Hidden Emotion* being easier than *Contents FB.* On average, CQ children scored 3.75 on the scale, almost identical to BJ children (3.71). Yet HK children scored lowered at 3.05, although the mean difference between the HK sample and the CQ sample was not statistically significant, $F(1, 271) = .06$, $p = .811$. Note that BJ sample was between 3 to 5 years of age, whereas CQ and HK were children between 4 and 6 years of age. When the similarity on ToM scale is combined with the difference in age, the BJ sample's advantage compared to the CQ sample is probably due to the difference in the social economic level between the two cities. The difference between HK data and Mainland data, including BJ and CQ sample, is rather intriguing.

Table 10.6

Item measures from CQ and HK sample as well as other samples from the literature

	CQ	HK	AA	BJ
Hidden Emotion	5.49	3.92	7.73	6.36
Contents FB	5.00	5.00	5.00	5.00
Diverse Belief	4.50	3.36	2.43	3.65
Knowledge Access	2.90	1.85	3.61	2.80
Diverse Desire	0.86	1.11	0.48	0.75
M	3.75	3.05	3.85	3.71
SD	1.69	1.41	2.44	1.91

In summary, both Guttman scaling and Rasch modeling of the 5 items in the ToM measure found that:

1. *Knowledge Access* was easier than *Diverse Belief* for both CQ and HK children, confirming Wellman and colleagues' finding with the Chinese children;
2. HK children scored lower than CQ children on the scale, even though the difference was not statistically significant. Moreover, *Hidden Emotion* was easier than *False Belief* for HK children, similar to that Peterson et al. (2005) found in autistic children.
3. Guttman scale score correlated highly with age in months. Differences between any consecutive items in the scale were not unanimously significant in both samples. Guttman scaling produced acceptable coefficients of reproducibility, but low coefficients of scalability. Coefficients of scalability did not reach a significant level in both samples after deleting *Hidden Emotion* or *Diverse Belief*.
4. However, Rasch modeling revealed the item difficulties formed a scalable progression in development. Fit Statistics showed the scales fit the data well, except for *Hidden Emotion* in the CQ sample.

10.4 Discussion

Overall, the ToM measure formed reasonably scalable progressions in both samples. It generated comparable scale scores as an indicator of ToM development. The sequences of the scale from the two samples largely replicated Wellman and colleagues' samples; especially the CQ sample in this study generated the exact same sequence as

Wellman and colleagues' BJ example, indicating the ToM scale measures a stable developmental phenomenon. It was also interesting that there were cultural specificities in the current samples. Due to the differences in the scale sequence, as well as the comparability between ToM scale items and the learning tasks in the current study, it is sensible to use other indicators of ToM development, such as false belief understanding, as supplements in the discussions of the relation between ToM development and *mindful learning*.

10.4.1 Challenge to the Cultural Universality Claim

Studies on children's false belief understanding from different cultures support a linear relationship between age and false belief understanding during preschool years (Avis & Harris, 1991; Callaghan et al., 2005). Wellman et al.'s (2001) meta-analysis showed that children's performance on false-belief task demonstrated a consistent developmental pattern, not only across various task manipulations, but also across various countries. The authors argued that, instead of a culture-specific product of socialization within literate, individualistic Anglo-European cultures, "[a] mentalistic understanding of persons that includes a sense of their internal representations - their beliefs - is widespread" (p.679).

Liu, Wellman, Tardif, and Sabbagh (2008) further performed a meta-analysis with false belief studies conducted with Chinese children, both Mandarin speaking Mainland Chinese children and Cantonese speaking Hong Kong children. They found that in spite of the cultural and linguistic differences, the Chinese children's trajectory of development was similar to that found in North American children, with false belief performance increasing with age during early childhood years, from below-chance to above-chance.

As convincing as the evidence is, inconsistencies exist among false belief studies conducted in different parts of the world. Children from different cultures develop false belief understanding at different paces, a fact that Wellman and colleagues (2001, 2006) acknowledged. They found, for instance, Hong Kong children performed above-chance on the false belief tasks starting from 64 months, more than 2 years later than Canadian children's 38 months. A similar delay was found in Japanese children, using standardized tasks (Naito & Koyama, 2006). If nonstandard task adaptation in non-literate, more traditional communities such as Quechua speaking Peruvian Indian children is considered, evidence showed they began to perform at above-chance level as late as around 80 months (Vinden, 1996).

The delay of false belief understanding in low social economic status children (Curenton, 2003; 2004; Holmes, Black, & Miller, 1996; Shatz, Diesendruck, Martinez-Beck, & Akar, 2003) and children with atypical development such as deafness (Peterson, 2004) also suggested that even within a given country, the communication styles, explanatory language and the use and conceptual framework of mental states themselves may vary greatly among different sub-cultural groups and may impact the ways in which ToM develops (Curenton, 2003).

If the parallel development of false belief understanding among cultures and linear relationship between age and false belief understanding really indicate a culturally universal conceptual change, the different sequential step of the ToM scale found in autistic children (Peterson et al., 2005) and Chinese children (Liu et al., 2008; the current study) indisputably argues against a culturally universal claim and suggests a more complex developmental mechanism of general mindreading ability across cultures. Using multiple items, the ToM scale measures a broader spectrum of children's mental state understanding than a single false belief task does. The available data seem to imply that functional mindreading ability could be reached via different developmental routes in different social, cultural, and linguistic contexts, as well as through culture specific socialization processes (Vinden, 1999; 2001).

10.4.2 Culture Specific ToM Development

Why Chinese children, including Hong Kong children, demonstrate a different pattern in ToM development from that of Western children? It has been suggested that biological constraints and cognitive recourses such as working memory and executive function affect children's false belief understanding (e.g., Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002, Frye, Zelazo, & Palfai, 1995). Chinese parents highly value behavioral inhibition (Chen et al., 1998). Studies have found that Chinese children, including Hong Kong children, outperformed their U.S. counterparts on executive functioning. Nonetheless, that does not translate to a corresponding advance in false belief understanding. On the contrary, their false belief understanding was not more superior, but even worse than Western children (Sabbagh, et al., 2006; Tardif, et al., 2007).

The second candidate for explaining culturally specific ToM development is language. It has been argued that specific linguistic features such as mental state verbs and sentential complement syntax affect children's mental state understanding (e.g., de Villers & de Viller, 2000; Lohmann & Tomasello, 2003; Perner, Sprung, Zauner, & Haider, 2003). Mandarin and Cantonese do not have an explicit marker for syntactic complementary clause such as *that* and *which* in the English language. And mental state verbs such as *believe* and *think* in Mandarin and Cantonese are more complex than those in English, some of which are neutral with respect to the truthfulness of beliefs, while others imply a false belief. Evidence supports the effect of linguistic features of the Chinese language on children's false belief understanding (Lee, Olson, & Torrence, 1999; Liu et al., 2008). Neutral mental verbs were intentionally chosen in false belief statements in the current study. Compared to specific linguistic features, recent studies with children speaking Cantonese suggest that general language ability contributes more to children's false belief understanding (Cheung, 2006; Tardif et al., 2007). A recent meta-analysis (Milligan, Astington, & Dack, 2007) on the relation between language development and false belief understanding (104 studies, N = 8891) found that controlling for the effect of age, the correlation between language and false belief had a moderate to large effect size before the age of 7. General language ability had a stronger tie with false belief than receptive vocabulary measures. Stronger effects were found when using earlier language to predict later false belief, but not the reverse.

Neither executive control nor language could fully explain the Chinese children's ToM development, which leaves culture and socialization. It is proposed that children's mental state understanding is greatly shaped by cultural beliefs and social practices (e.g., Garfield, Peterson, & Perry, 2001; Lillard, 1998, 1999; Tomasello, 2000). Wellman et al. (2006) suggested that the reason for the Chinese children's earlier acquisition of the concept of ignorance but later acquisition of diverse belief lies in the culture that emphasizes *knowing* instead of *belief*. The Western analytic mode of thinking from the Greek tradition supports reasoning that emphasizes truth, falsity, and difference in beliefs; the Eastern epistemology, however, focuses more on the holistic reasoning with dialectic arguments (Nisbett, 2003). Accentuating pragmatic knowledge acquisition (Li, 2002), Chinese parents predominately commented on *knowing* in their conversation with young children (Tardif & Wellman, 2000). In contrast, American parents commented more on *thinking* (Bartsch & Wellman, 1995). Although the sequence of Chinese children's acquisition of mental verbs was similar to the American children, they demonstrated far less use of the terms for *thinking* (Tardif & Wellman, 2000).

As for the discrepancy in the sequence of emotion understanding and false belief understanding among children from different cultures, it is argued that the understanding of emotion may involve a different facet of social cognition than epistemological mental states understanding (Cutting & Dunn, 1999). Even though the two demonstrated a developmental sequence of some sort, it is possible that they may undertake different developmental paths that are independent of each other. For example, highly functional autistic children are successful with perceptions, images, and emotional understanding compared to epistemological mental states understanding (Carruthers, 2009). A study with post-institutionalized children found a delay in false belief understanding but not in emotion understanding (Tarullo, Bruce, & Gunnar, 2007). The authors argued that false belief delay might be associated with language delay, early risk factors, early social deprivation, and poor inhibitory control, whereas understanding of emotion might not.

Naito and Koyama (2006) argued that the interdependence and collectivism of Asian cultures (e.g., Triandis, 1989) socialize children to be sensitive to behavioral rules, utterances, and contextual interpersonal cues, but not to internal mental states. Empirical studies had shown that mental states understanding is influenced by family structure and parenting styles (e.g., Cassidy, Fineberg, Brown, & Perkins, 2005; Meins et al., 2003;

Ruffman, Slade, Devitt, & Crowe, 2006). Children with mind-minded parents or older siblings are exposed to mental states conversations more often and therefore demonstrate more advanced mental states understanding than their peers. In contrast, parents' use of power assertion in their conversation was found to be negatively associated with children's belief understanding (Pears & Moses, 2003).

Chinese parents use less mental state talk but more power assertion in their conversations with children to reinforce correct behaviors (Chen & Lin, 1994; Wang, Leichtman, & Davies, 2000; Wellman et al., 2006). The socialization process that emphasizes conformity and harmony within groups and acceptable behavioral standards might explain the Chinese children's advanced emotion understanding. In both CQ sample and HK sample, younger children found emotion understanding easier than false belief understanding. This pattern suggests that the scale is less stable for younger children. Before they have a grasp of false belief, they could somehow get by through contextual cues on emotion, such as by detecting the "face color," as the Chinese would say.

The discrepancy in the developmental sequence between Mainland Chinese children and Hong Kong children echoes Wellman's group's finding (Liu et al., 2008) of Hong Kong children's delay in false belief understanding compared to Mainland children. Hong Kong children in this study began to perform above chance level on false belief task at 67 months, compared to 62 months for the CQ sample. Liu et al. found the result intriguing and hard to explain, since all the factors seem to favor Hong Kong children over Mainland children, such as having more siblings, mostly bilingual, and having a more Westernized culture.

It is suspected that linguistic differences between Cantonese and Mandarin might be relevant to the difference in children's ToM development (Liu et al., 2008). However, it is not likely to be the case since the difference between Cantonese and Mandarin is mainly dialectic; the two share the same written characters. Mainland Chinese from the southern provinces of Guang Dong (also known as Canton) and Guang Xi also speak Cantonese. It is an empirical question whether the differences between Mainland Chinese children and Hong Kong children's ToM development is due to the language difference. The CQ sample and Wellman's BJ sample were from non-Cantonese speaking areas; and the origins of samples in Liu et al.'s (2008) meta-analysis were unspecified. Future studies with sampling from Cantonese speaking areas in Mainland China would shed light on the language issue.

Hong Kong children's delay in false belief understanding and reversed sequence between emotion and false belief support the culturally specific ToM development thesis. Hong Kong people and Mainland Chinese are from the same ethnic groups. Originated in the same geographic area and sharing the same cultural tradition, the colonial history of the past one hundred and some years in Hong Kong is the most significant difference between Hong Kong people and Mainland Chinese. A closer examination into the Hong Kong society would help to understand the differences between the two locales and the different pattern of Hong Kong children's performance on the ToM scale. The highly competitive nature of Hong Kong society makes children's life more stressful (Chan & Chan, 2004). Hong Kong families implement more parental control over children, compared to the Mainland (Cheung, Ngai, & Ngai, 2007). Hong Kong children, especially younger children, have lower self-concepts compared to their counterparts in the Mainland (Hui, Lau, Li, Tong, & Zhang, 2006; Lau, Li, Chen, Cheng, Siu, 1998).

In the school context, Hong Kong preschool teachers strongly believe in teacher directed teaching; as a result, children have less free play or interaction with peers in preschools (Cheng, 2001). Most of the Hong Kong preschool programs are half-day programs, which means children spend 3 hours a day in school. Cheng and colleagues' recent study (Cheng, Lau, Fung, & Benson, 2009) found that on average, Hong Kong children spend 140 minutes of their 180 minutes in preschools everyday following the teacher's central instruction, even during free play time and toilet time. A personal observation gives the impression that Hong Kong children are polite but docile. Preschool education in Hong Kong is run by private organizations, a large proportion of which are religious and charity groups. Moral doctrines such as obedience, endurance, harmony, and keen observation (meaning knowing others' need and satisfying it before others even ask) are on some schools' curricula. In the current study, 84% of the HK children were from Christian schools.

Growing up in Hong Kong society, children have a fair share of training in understanding other people's emotions and keeping a peaceful social relationship, but not much in understanding epistemological beliefs. Future studies should investigate socialization factors and their relation with children's ToM development in Hong Kong.

CHAPTER ELEVEN

General Discussion

11.1 The Development of Mindful Learning

Six studies exploring children's awareness of how learning occurs found that children's understanding of learning developed during the preschool and early elementary school years and was correlated with their emerging ToM ability. Referring to the research questions proposed in *Chapter Three*, the main findings of the current study can be summarized as the following:

1. Children's understanding of learning as knowledge change developed between 4 and 6 years of age, during preschool and early elementary years.

Between 4 and 6 years, children came to understand that learning is the process of representational knowledge change. Young children started with a behavioral understanding of learning. They understood that moving from not knowing to knowing is learning. However, they tended to over-attribute learning to failed attempts, and predict everyone needed to learn no matter whether the person knew the knowledge of interest or not. They seemed to follow a behavioral hint when making predictions that those who had learned before would do it again in the future. Younger children also found it difficult to differentiate learning that happened recently from learning that happened a while ago, similar to Taylor et al.'s (1994) findings. With age, children gradually realized that learning is a mental representational change; and one does not need to learn what one already knows. Their learning judgments and predictions improved with age.

2. Children found it extremely difficult to differentiate learning from mere actions that resemble learning but without the mental representational change; even

6-year-olds could not tell the difference between genuine learning and behavioral change.

Children's difficulty with failed learning was magnified in Study 2 and Study 3 when a conflict was presented between the behavioral outcome and the mental representation. They were drawn to the resemblance between a behavioral change and learning, and tended to over-attribute learning to events without a genuine knowledge change. Children tended to conclude that a person who could draw a circle that perfectly resembles a letter *O*, yet without the mental representation of the letter knew how to write a letter *O* and learned the knowledge in the action. Even though 6-year-olds finally responded that the person in the *Coincidence* tasks did not know at the end of the stories, they still thought the person learned, which revealed an incoherent, behavioral concept of learning independent of knowledge change.

3. Familiarity with the learning contents affected children's learning judgments; the effect varied for children of different ages.

There was a significant improvement in children's learning judgments in the familiar learning contexts from 4 to 6 years of age in Study 3. Children's learning judgments in novel learning contexts, however, remained unchanged during the same period. Younger children might assume everybody else knew exactly what they knew due to epistemic egocentrism and therefore concluded both persons with or without genuine knowledge change learned. They picked between the two randomly. Older children, on the other hand, might be able to simulate their own experience of learning in their judgments. When the learning contents were novel to children themselves, children could resort to neither epistemic egocentrism nor simulation to help with the learning judgments.

4. Children began to appreciate that people's learning intention was based on their beliefs about knowledge states; yet even 6-year-olds still had trouble understanding learning intentions based on false beliefs.

Study 4 and Study 5 found it was easier for children to understand the implications of true belief in learning than false belief. In Study 4, even though the beliefs about the knowledge states were explicitly stated in the stories, children tended to reprocess the belief information in case of false belief. Learning necessity was easier than learning intention when controlling for yes bias and belief status, since the former is based on knowledge state and the latter is based on belief. Study 5 found that children up to 6 years of age failed to recognize the subjectivity of false belief by treating false belief the same as ignorance in learning intention prediction. The idiosyncrasy of the false belief might have made the contrast between true knowledge and ridiculous false belief more salient for children, which probably explains why it was easier for children to judge who would need to learn between the knowledgeable person and the person with false belief than between the knowledgeable person and the ignorant person.

5. Children appreciated learning intention as a causal force of the learning outcome. However, even 6-year-olds still found the conflict between learning intention and learning outcome hard to comprehend.

Study 6 found that children did better with tasks where the intention and the learning outcome were in consistent with each other than with tasks where the two were in conflict with each other. They were more likely to reprocess one aspect, usually the learning intention instead of the learning outcome, to make it in line with the other in conflict tasks. Children did recognize that intention affects learning outcome; they understood that positive intention is usually associated with positive outcome, and vice versa. The fact that children could make perfect learning judgments based on physical cues independent of intention suggested that they understood to some extent that intention is neither a sufficient nor a necessary condition for learning. However, even 6-year-olds found the conflict between learning intention and learning outcome hard to comprehend.

6. Children's learning understanding was correlated with their emerging ToM ability, particularly false belief understanding represented by the sum of *Content False Belief* and *Knowledge Access.*

Across the six studies, various indicators of ToM were significantly correlated with children's learning understanding when holding the effect of age constant. However, the most consistent correlations were between learning understanding and the sum of *Content False Belief* and *Knowledge Access*, rather than the overall ToM score. The two tasks share a similar format and similar false belief construct. It seems false belief is the main player in *mindful learning* development, which is cross validated in Study 5 where common sense knowledge, most evident self knowledge such as one's own sex and name, as well as factual knowledge in classic false belief stories all revealed the same outcome patterns in the learning prediction questions. The agreement suggested children's difficulty in learning tasks was inherently the same with that in ToM development as represented by false belief.

7. ToM measure with both mainland Chinese children and Hong Kong children generated reasonably scalable progressions, which largely replicated the sequence from other samples. Nevertheless, the differences between the current data and those from the literature did suggest culture specific characteristics of ToM development.

Adopting the well-documented ToM scale enables comparison between current data and that in the literature. The current samples were one year older than comparable samples in the literature; yet they shared similar passing rate on ToM items, indicating Chinese children develop ToM understanding later than their Western counterparts. HK children scored lower than CQ children on the scale, even though the difference was not statistically significant. *Knowledge Access* was easier than *Diverse Belief* for both CQ and HK children, similar to what was documented in the literature with Chinese children. Younger children in both mainland and Hong Kong samples demonstrated more advanced emotion understanding compared to false belief understanding. HK children even demonstrated a reversed sequence between *Hidden Emotion* and *False Belief*, similar to Peterson et al.'s (2005) autistic children's pattern. The evidence suggested that children in different cultures might develop ToM understanding via different routes.

11.2 Mindful Learning and ToM Development

The current research demonstrated a moderate correlation between *mindful learning* and children's general mental state understanding. It is argued that relation between the two constructs might be bidirectional (Davis-Unger & Carlson, 2008): it is likely that mature mindreading ability facilitates understanding of teaching and learning; it is also possible that exposure to conflicting perspectives and knowledge differences may enhance their understanding that beliefs can be inconsistent with reality (Wellman & Lagattuta, 2004). It is proposed here, however, that the division of two aspects might simply be an artifact of the divorce between two distinct research traditions and two sets of terminologies. Instead of considering which caused which in the process of development, people ought to really start to think about ToM development and the understanding of teaching and learning in one coherent theoretical framework. Both of the two aspects deal with how children understand knowledge acquisition, and other mental processes associated with it. As Frye and Ziv (2005) pointed out, ToM research has been in the past ironically focused on false belief and deception instead of the acquisition of true belief, i.e., learning. It is time now to unite different research traditions under the proposed overarching framework of *mindful learning*. The idea of one united psychological entity calls attention to the positive aspect of the ToM research. In addition to the attention-catching discussion on deception and false belief, research into children's mental state understanding can have more far-reaching implications in general cognitive development.

It has been pointed out that the development of executive functioning, including working memory and inhibitory control, contributes to children's performance on cognitive tasks, especially those with conflict such as the false belief tasks (e.g., Carlson et al., 2002; Carlson & Moses, 2001; Frye et al., 1995). Children's executive functioning was not measured in the current study. Yet considering previous reports on Chinese children's advanced executive functioning and disassociation between executive functioning and false belief performance (Meristo & Hjelmquist, 2009; Oh & Lewis, 2008; Sabbagh et al., 2006; Tardif et al., 2007), it is reasonable to believe that *mindful* *learning* is a qualitatively distinct construct that contributes to children's cognitive development in addition and independent of executive functioning. Further study should consider controlling children's executive functioning in the discussion of *mindful learning*.

11.3 Mindful Learning, Metaknowing, and Personal Epistemology

Mindful learning bridges the research in metacognition and personal epistemology in general. Focusing on early knowledge about the mental world, *mindful learning* from a ToM perspective complements metacognition research, which mostly focuses on school age children and adults. *Meta-knowing* (Kuhn, 1999), as an umbrella terminology (Schneider, 2008), argues for the far-reaching meaning of mental awareness in cognition. Empirical studies have suggested a connection between children's ToM understanding and their own teaching (Davis-Unger & Calson, 2008; Strauss, Ziv, & Stein, 2002); as well as that between conceptualization of teaching and later school performance (Blair & Razza, 2007; Woodburn, 2008). It is reasonable to believe that children's understanding of the concept of learning should affect their school success too. Further research should consider examining how *mindful learning* facilitates children's learning performance and cognitive development in general, as well as the possibility of facilitating school entry from a mindreading perspective.

Kuhn (2000a) proposed that children's epistemological understanding develops in a four-step sequence of realist, absolutist, multiplist, and evaluatist. Ziv and Frye (2004) suggest that achieving false belief understanding during preschool years upgrades children from realists to absolutists in terms of epistemological understanding by recognizing objective knowledge and belief independent of single, true reality. It is reasonable to predict that later appreciation of local knowing in individual agents may facilitate children's understanding of multiple subjective interpretations that different people may have towards the same reality. Future study should investigate the relation between interpretive ToM (Chandler & Carpendale, 1996; Chandler & Lalonde, 1996) in middle childhood and the development of multiplist or even evaluatist epistemological understanding.

11.4 Implications for Early Childhood Education

Form a *mindful learning* perspective, the issue young children are facing is not exactly how to practice Dewey's (1915) idea of *learning by doing*, but rather how to grow out of the concept of *learning IS doing*. Preschool curricula can keep children busy in doing all sorts of hands-on activities, but do children really have an idea of what they are doing? A child who thinks the goal of school activity is to do or play would not take the responsibility and make the effort to learn. Teachers need to engage children mentally in learning by stressing the distinction between behavioral change and representational change.

Constructivist learning theory suggests that knowledge is socially constructed and the child is an active participant in meaning making (Wood, 1998). At the frontier of the constructivism movement is early childhood education, which embraces progressive/constructivism educational reform and promotes child-centeredness and developmental appropriateness (National Association for the Education of Young Children (NAEYC), 2009). Early childhood education nowadays avoids direct instruction and intentional learning, and prefers scaffolding and learning by doing instead. The very idea of learning by doing and cognitive apprenticeship is to apply the observation and imitative learning style in natural settings to school learning. However, since school work deals with much more cognitively challenging skill sets, it is disputable whether such an approach would still work (Bjorklund & Bering, 2002; Kirschner et al., 2006; Mayor, 2004; Wang, 2009). A review of the effectiveness of Developmentally Appropriate Practices (DAP) actually found no evidence of consistent effects of DAP for cognitive or academic outcomes (Van Horn, Karlin, Ramey, Aldridge, & Snyder, 2005).

From an evolutionary developmental psychology perspective, modern schooling emerged rather late in human evolution when observational learning became insufficient for mastering the accumulated knowledge transferred from generation to generation, especially after the invention of literacy. Learning in the school context therefore has to be effortful, with sustained attentional control and working memory resources (Geary, 2005). Unlike experts, learners with little or no prior knowledge - the so called novices - do not possess the underlying mental models necessary for learning by doing. Based on cognitive load theory (Sweller, 1988, 1999), structured learning activities such as worked examples function the best for the novices (Kirschner et al., 2006).

Voices promoting direct instruction and intentional learning began to emerge in recent years. Klahr and Nigam (2004) found when compared to discovery learning, direct instruction in elementary science yielded favorable results. Brown (2008) found that associating learning and assessment with fun rather than with hard work was actually negatively correlated with grade school children's academic performance. Learning certainly is not fun and requires hard work. When discussing preschool children's mathematics development, Ginsburg, Lee, and Boyd (2008) stated bluntly in the Society for Research in Child Development (SRCD)'s *Social Policy Report*, that "(p)reschool teachers need to engage in deliberate and planned instruction…" (p.8).

Based on the assumption that teaching and learning are reciprocal processes involving intentional engagement and awareness of knowledge difference, Frye and colleagues (Frye & Wang, 2008; Frye & Ziv, 2005) identified four types of teaching and learning: *uninstructed development* with no intention in either teaching or learning; *scaffolding and discovery learning* with teaching intention but no learning intention; *imitation and observational learning* with learning intention but no teaching intention; and *direct instruction and collaborative learning* with both teaching and learning intention. Young children have various degrees of understanding regarding to the teaching and learning scenarios involving different levels of intention. It would not make sense to reason that they would react to different forms of teaching and learning the same way as older children do (Frye & Wang, 2008), which calls for closer examination of some early childhood pedagogies.

For example, early childhood teachers need to take children's developmental level on *mindful learning* into consideration when applying constructivist pedagogy such as the K-W-L model. It does not mean that teachers have to wait till children fully understand knowledge change, belief, and learning intention before applying such teaching and learning models. Instead, small-steps, closely scaffolded instruction ahead of children's levels enhances development. Teachers should help children to understand that learning is a mental process, with a purpose of knowing instead of doing. Contrasts between knowledge states and between beliefs, as well as explicitly stated teaching and learning goals would help to engage children mentally.

Humans are programmed to learn from each other (Bloom, 2000; Harris, 2007), as well as to teach (Strauss, Ziv, & Stein, 2002). Children are in school to learn things they would not learn otherwise following their biological timetable of maturation. Effortful teaching and intentional learning should without doubt be the central task for formal schooling. If entering school can be seen as the dividing threshold between natural learning and academic learning, *mindful learning* should be the vital component of school readiness (Wang, 2009).

Appendix A: Theory of Mind Scale
Wellman & Liu   University of Michigan

ANY USE OF THIS SCALE OR TRANSLATIONS OF IT SHOULD CITE WELLMAN & LIU (2004) AND PERMISSION FROM WELLMAN & LIU (H.M. Wellman & D. Liu, 2004, Scaling of theory of mind tasks. *Child Development*, *75*, 523-541)

These tasks are presented in order of least to most difficult (for preschoolers). They should NOT be presented in exactly this order, BUT Not-Own Desire should come first (so children begin with an easy task to understand) and Hidden Emotion should come last. We suggest the order: Diverse- Desire, Knowledge-Access, Contents False Belief, Diverse Belief, Explicit False Belief, Hidden Emotion. If two orders are needed then we recommend the following for a second order: Diverse- Desire, Explicit False Belief, Diverse Belief, Contents False Belief, Knowledge-Access, Hidden Emotion. Note: Explicit False Belief is NOT an item in the “official” 5-item scale. So it is often omitted. (It is included here just for those who want to include two false-belief tasks, one within the scale itself and one additional in a format comparable to the rest of the scale. See Wellman & Liu 2004 for details.)

All tasks use small toy figurines and pictures, to present the contents.

<u>Diverse Desire</u>

Props: Small figurine of man. Plus 8.5x11 piece paper (laminated) with colored realistic drawing of carrot on one half and cookie on the other.

Story: Here's Mr. Jones (place figure next to picture, midway between two items). It is his snack time. So, Mr. Jones wants a snack to eat. Here are two different snacks: a carrot (point) and a cookie (point).

Own Desire: Which snack would **YOU like** best? Would you like a **carrot** (point) **or**…a **cookie** (point) best?

___ If carrot: Well, that's a good choice, **BUT**…Mr. Jones **REALLY LIKES cookies** (don't point). He doesn't like carrots. What he **likes best** are cookies.

___ If cookie: Well, that's a good choice, **BUT**…Mr. Jones **REALLY LIKES carrots** (don't point). He doesn't like cookies. What he **likes best** are carrots.

Question: So, now it's time to eat. Mr. Jones can only choose **one** snack, **just one**. Which snack will Mr. Jones (point to Mr. Jones) **choose**?…A carrot or…a cookie?

___ carrot ___ cookie

SCORING: To be scored as correct, or to "pass" this task, the child must answer the *target* question opposite from his/her answer to the *own-desire* question.

<u>Diverse Belief</u>

Props: Small figurine of girl. Plus 8.5x11 piece paper (laminated) with colored realistic drawing of bushes on one half and garage on the other.

Story: Here's Linda (place figure on table next to picture midway between two items). Linda wants to find her cat. Her cat might be hiding in the bushes (point) or…it might be hiding in the garage (point).

Own Belief: Where do **YOU think** the cat is? **In the bushes** (point) **or**…**in the garage** (point)?

___ If bushes: Well, that's a good idea, **BUT**…Linda **THINKS** her cat is **in the garage** (don't point). She **thinks** her cat is in the garage.

___ If garage: Well, that's a good idea, **BUT**…Linda **THINKS** her cat is **in the bushes** (don't point). She **thinks** her cat is in the bushes.

Question: So…where will Linda (point to Linda) **look** for her cat?…In the bushes or…in the garage?

___ bushes **___** garage

SCORING: To be scored correct the child must answer the *target* question opposite from his/her answer to the *own-belief* question.

<u>Knowledge Access</u>

Props: Small nondescript rectangular container with a single drawer. Toy dog to fit in drawer. Small figurine of girl.

Experimenter: Here's a drawer (keep finger over drawer).

Question to child: What do you think is inside the drawer (point to drawer)?
(If child gives an answer): _______________

Experimenter: (With drama) Let's see…it's really **a DOG** inside!
(Pull out drawer to show dog. Close the drawer to restrict view again after a pause)

Post-view Question: Okay…what is in the drawer? _______________
(If child makes an error here, show contents inside again until child gets this question correct)

Experimenter: Polly has **never ever seen** inside this drawer. (Take Polly out) Now here comes Polly.

Question: So…does Polly **KNOW** what is in the drawer?
___ yes ___ no
Did Polly **see** inside this drawer?
___ yes ___ no

SCORING: To be scored correct the child must answer the *target* question "no" and answer the *memory* control question (the last question about seeing) "no."

<u>Explicit False-Belief</u>

Props: Small figurine of boy. Plus 8.5x11 piece paper (laminated) with colored realistic drawing of closet on one half and backpack on the other.

Story: Here's Scott, and Scott wants to find his mittens. Scott's mittens may be in his backpack (point) or…they may be in the closet (point). Well…**Really**, Scott's mittens are **really** in his backpack (point and pause)—but Scott **THINKS** his mittens are **in the closet** (point).

Questions: So…where will Scott (point to Scott) **look** for his mittens?…In his backpack or…in the closet?

___ backpack ___ closet

Where are Scott's mittens **really**?…In his backpack or…in the closet?

___ backpack ___ closet

SCORING: To be scored correct the child must answer the *target* question "closet" and answer the *reality* question (the last question) "backpack."

Contents False-Belief

Props: standard Band-aid box with picture of band-aid prominently on front. Toy pig to fit in box. Small figure of a boy.

Experimenter: Here is a Band-Aid box.

Question to child: What do you think is inside the Band-Aid box? ________________

(Prompt child to say Band-Aids if necessary: for example,
first prompt, "Does it look like there would be Band-Aids inside?"
second prompt, "What kind of box is this? What should be in here?"
third prompt, "Should there be Band-Aids in here or books in here?")

Experimenter: (With drama) Let's see…it's really **a PIG** inside! (Pour pig out) (Close the lid to restrict view again after a pause)

Post-view Question: Okay…what is in the box? ________________

(If child makes an error here, show contents inside again until child gets this question correct)

Experimenter: Peter has **never ever seen** inside this Band-Aid box. (Take Peter out) Now here comes Peter.

Question: So…what does Peter **THINK** is in the box? Band-Aids or a Pig?

(Reiterate choice again if child still does not answer)

___ Band-Aids ___ Pig

Did Peter **see** inside this box?

___ yes ___ no

SCORING: To be scored correct the child must answer the *target* question "Band-Aids" and answer the *memory* question (the last question about seeing) "no."

<u>Hidden Emotion Scale Pre-training</u>

Props: Picture (about 3x3) showing drawing of back of a boy's head (not face or expression). Emotion scale: a strip (about 3x10) of three simple "faces" (bare-bones "smiley"-type black-and-white faces of just circular outline plus simple eyes and line-like mouths): one happy, one sad, and (in middle of strip) one neutral.
Experimenter: Now, I'm going to tell you a story about a boy. (**Take out emotion scale**) In this story, the boy might feel happy (**point**). He might feel sad (**point**). Or He might be not feel happy or sad, just OK (**point**).
Can you point to the face that is:

___ Sad?
___ OK?
___ Happy?

(Train child again if child makes a mistake)
Experimenter: Okay, now about the story: After I've finished the story, I'm going to ask you about how the boy really feels, inside (pat own chest), **AND** how he looks on his face (pat own cheek). How he **really feels inside** (pat own chest) may be the same as how he **looks on his face** (pat own cheek), or they may be different.
(At this point the emotion scale is pushed to one side. The child does not have to answer the target questions by pointing at the scale. The scale remains in sight but out of the way just to provide a visual reminder of the warm up, unless child is unusually nonverbal.)

Hidden Emotion Negative

Experimenter: This story is about Matt (show figurine's back). Matt's friends were playing together and telling jokes. One of the older children, Rosie, told a mean joke about Matt and everyone laughed. Everyone thought it was very funny, but NOT Matt. **But**, Matt **didn't** want the other children to see how he felt about the joke, because they would call him a baby. So Matt tried to hide how he felt.

Memory Check: What did the other children do when Rosie told a mean joke about Matt?

____

(Correct answer: laughed or thought it was funny…if the child gets the answer wrong, tell the story again)

In the story, what would the other children do if they knew how Matt felt?

____

(Correct answer: call Matt a baby or tease him …if the child gets the answer wrong, tell the story again)

Question: So…how did Matt **really feel** (pat own chest), when everyone laughed — Happy, Sad, or Okay? (Note: the examiner should not show any feelings) (Reiterate choice again if child still does not answer)

___ Happy ___ Sad ___ Okay

How did Matt **try to look** on his face (pat own face), when everyone laughed—Happy, Sad, or Okay? (Note: the examiner should not show any feelings)

(Reiterate choice again if child still does not answer)

___ Happy ___ Sad ___ Okay

SCORING: To be scored correct the child must answer the first question more negatively than the second question.

Appendix B: An example of the tasks of Study 1

1. Successful Learning:

Do you know how to draw a square? Can you draw a square for me?

This is Andrew. Andrew **cannot** draw a square. He just can't.

Pre-event memory check: Can Andrew draw a square? **Yes** **No**

Teletubby can draw a square. Today in school, Andrew watches Teletubby drawing a square. Teletubby draws like this: □. Then Teletubby asks Andrew: “Can you draw a square?” Andrew says: **“Yes, I can.”** Andrew **can** draw a square. He draws like this: □.

Post-event memory check: Can Andrew draw a square? **Yes** **No**

Learning: Did Andrew **learn** how to draw a square today? **Yes** **No**

Prediction: When Andrew goes home after school, he wants to draw a square. Does he **need** to learn how to draw a square? **Yes** **No**

2. Failed Learning:

Do you know how to count to 3? Can you count these for me?

This is Cindy. Cindy **cannot** count to 3. She just can't.

Pre-event memory check: Can Cindy count to 3? **Yes** **No**

Teletubby can count to 3. Today in school, Cindy watches Teletubby counting to 3. Teletubby counts like this: “1, 2, 3.” Then Teletubby asks Cindy: “Can you count to 3?” Cindy says: **“No, I cannot.”** Cindy **cannot** count to 3.

Post-event memory check: Can Cindy count to 3? **Yes** **No**

Learning: Did Cindy **learn** how to count to 3 today? **Yes** **No**

Prediction: When Cindy goes home after school, she wants to count to 3. Does she **need** to learn how to count to 3? **Yes** **No**

3. Previous Learning:

Do you know how to write the letter *C*? Can you write a letter *C* for me?

This is Even. Evan **can** write a letter *C*. He learned that **a long time ago**. He writes like this: *C*.

Pre-event memory check: Can Evan write a letter *C*? **Yes** **No**

Teletubby can write a letter *C*. Today in school Evan watches Teletubby writing a letter C. Teletubby writes like this: *C*. Then Teletubby asks Evan: “Can you write a letter *C*?” Even says: **“Yes, I can.”** Evan **can** write a letter *C*. He writes like this: *C*.

Post-event memory check: Can Evan write a letter *C*? **Yes** **No**

Learning: [1]Did Evan learn how to write a letter *C* **today,** or did he learn that **a long time ago**? **Today** **Long ago**

Prediction: When Evan goes home after school, he wants write a letter *C*. Does he **need** to learn how to write a letter *C*? **Yes** **No**

[1]The two options are counterbalanced.

Appendix C: An example of the tasks of Study 2

1. Coincidence:

Do you know how to write the letter *O*? Can you write a letter *O* for me?
This is Grace. Grace **cannot** write the letter *O*. She just can't.

Pre-event memory check: Can Grace write the letter *O*? **Yes** **No**

Today in school, Grace draws a circle. It looks **just like** the letter *O*. Teletubby sees it and says to Grace: "That's a nice circle, you just drew a nice circle." Only Grace **does not** know that's how you write the letter *O*.

Post-event memory check: Did Grace draw a circle that looks **just like** the letter *O*? **Yes** **No**

Knowledge state: Did Grace **know** that's how you write the letter *O*? **Yes** **No**

Learning: Did Grace **learn** how to write the letter *O* today? **Yes** **No**

Prediction: When Grace goes home after school, she wants to write a letter *O*. Does she **need** to learn how to write the letter *O*? **Yes** **No**

2. Discovery:

Do you know how to write the number *1*? Can you write a number *1* for me?
This is Hansen. Hansen **cannot** write the number *1*. He just can't.

Pre-event memory check: Can Hansen write the number *1*? **Yes** **No**

Today in school, Hansen draws a line. It looks **just like** the number *1*. Teletubby sees it and says to Hansen: "**That's** how you write the number *1*, you just wrote a **number *1*.**" Now Hansen **knows** that's how you write the number *1*.

Post-event memory check: Did Hansen draw a line that looks **just like** the number *1*? **Yes** **No**

Knowledge state: Did Hansen **know** that's how you write the number *1*? **Yes** **No**

Learning: Did Hansen **learn** how to write the number *1* today? **Yes** **No**

Prediction: When Hansen goes home after school, he wants to write a number *1*. Does he **need** to learn how to write the number *1*? **Yes** **No**

Appendix D: An example of the tasks of Study 3

1. Familiar content: Duel Identity

Do you know how to write a letter *O*? Can you write a letter *O* for me?

These are Jun and Wei. They **cannot** write a letter *O*. They just can't.

Pre-event memory check:

Can Jun write a letter *O*? **Yes** **No**

Can Wei write a letter *O*? **Yes** **No**

Today in school, Jun and Wei each draw a circle: *O*. It looks **just like** letter *O*, doesn't it?

Jun shows his circle to Mickey Mouse. Mickey Mouse says to Jun: "This is a circle, you just drew a nice circle." Only Jun **does not** know this is how you write a letter *O*. He **does not** know this is a letter *O*.

Knowledge state: Does Jun **know** this is how you write a letter *O*? **Yes** **No**

Learning: Did Jun **learn** how to write a letter *O* today? **Yes** **No**

Wei shows her circle to Donald Duck. Donald Duck says to Wei: "This is a **letter *O***, you just wrote a **letter *O***." Now Wei **knows** this is how you write a letter *O*. She **knows** this is a letter *O*.

Knowledge state: Does Wei **know** this is how you write a letter *O*? **Yes** **No**

Learning: Did Wei **learn** how to write a letter *O* today? **Yes** **No**

Forced choice: [1]**Who** learned how to write a letter *O* today, Wei or Jun? **Wei** **Jun**

2. Familiar content: Copy

Do you know how to write a letter *Y*? Can you write a letter *Y* for me?

These are Hua and Mei Ran. They **cannot** write a letter *Y*. They just can't.

Pre-event memory check:

Can Hua write a letter *Y*? **Yes** **No**

Can Mei Ran write a letter *Y*? **Yes** **No**

Today in school, Hua and Mei Ran each copy a letter from the board: *Y*. It looks **just like** letter *Y*, doesn't it?

Hua shows her letter to Mickey Mouse. Mickey Mouse says to Hua: "This is a **letter *Y***, you just copied a **letter *Y***." Now Hua **knows** this is how you write a letter *Y*. She **knows** this is a letter *Y*.

Knowledge state: Does Hua **know** this is how you write a letter *Y*? **Yes** **No**

Learning: Did Hua **learn** how to write a letter *Y* today? **Yes** **No**

Mei Ran shows his letter to Donald Duck. Donald Duck says to Mei Ran: "This is a letter, you just copied a nice letter."Only Mei Ran **does not** know this is how you write a letter *Y*. He **does not** know this is a letter *Y*.

Knowledge state: Does Mei Ran **know** this is how you write a letter *Y*? **Yes** **No**

Learning: Did Mei Ran **learn** how to write a letter *Y* today? **Yes** **No**

Forced choice: [1]**Who** learned how to write a letter *Y* today, Hua or Mei Ran?

Hua **Mei Ran**

3. Familiar content: Spelling

Do you know how to spell the word *DOG*? Can you spell the word *DOG* for me?

These are Peng and Ying Ying. They **cannot** spell the word *DOG*. They just can't.

Pre-event memory check:

Can Peng spell the word *DOG*? **Yes** **No**

Can Ying Ying spell the word *DOG*? **Yes** **No**

Today in school, Peng and Ying Ying each put three letter blocks together: D-O-G. They spell **just like** the word *DOG*, don't they?

Peng shows his blocks to Mickey Mouse. Mickey Mouse says to Peng: "This is a line of blocks, you just did a good job putting these blocks together." Only Peng **does not** know this is how you spell the word *DOG*. He **does not** know this is the word *DOG*.

Knowledge state: Does Peng **know** this is how you spell the word *DOG*? **Yes** **No**

Learning: Did Peng **learn** how to spell the word *DOG* today? **Yes** **No**

Ying Ying shows her Blocks to Donald Duck. Donald Duck says to Ying Ying: "This is the word ***DOG***, you just spelled the word ***DOG***." Now Ying Ying **knows** this is how you spell the word *DOG*. She **knows** this is the word *DOG*.

Knowledge state: Does Ying Ying **know** this is how you spell *DOG*? **Yes** **No**

Learning: Did Ying Ying **learn** how to spell the word *DOG* today? **Yes** **No**

Forced choice: [1]**Who** learned how to spell the word *DOG* today, Peng or Ying Ying?

Peng **Ying Ying**

4. Unfamiliar content: Duel Identity

Do you know how to write the number 4 in Japanese? This is how you write a number 4 in Japanese: し.

These are De Xi and Le Le. They **cannot** write 4 in Japanese. They just can't.

Pre-event memory check:

Can De Xi write number 4 in Japanese? **Yes** **No**

Can Le Le write number 4 in Japanese? **Yes** **No**

Today in school, De Xi and Le Le each draw a hook: し. It looks **just like** number 4 in Japanese, doesn't it?

De Xi shows his hook to Mickey Mouse. Mickey Mouse says to De Xi: "This is a **number 4 in Japanese**, you just wrote a **number 4 in Japanese**." Now De Xi **knows** this is how you write number 4 in Japanese. He **knows** this is number 4 in Japanese.

Knowledge state: Does De Xi **know** this is how you write number 4 in Japanese?

Yes **No**

Learning: Did De Xi **learn** how to write number 4 in Japanese today? **Yes** **No**

Le Le shows her hook to Donald Duck. Donald Duck says to Le Le: "This is a hook, you just drew a nice hook." Only Le Le **does not** know this is how you write a number 4 in Japanese.She **does not** know this is number 4 in Japanese.

Knowledge state: Does Le Le **know** this is how you write number 4 in Japanese?

Yes **No**

Learning: Did Le Le **learn** how to write number 4 in Japanese today? **Yes** **No**

Forced choice: [1]**Who** learned how to write number 4 in Japanese today, De Xi or Le Le?

De Xi **Le Le**

5. Unfamiliar content: Copy

Do you know how to write the character for *Hat* in ancient Chinese? This is how you write the character for *Hat* in ancient Chinese: 冃.

These are Si Si and Yuan. They **cannot** write *Hat* in ancient Chinese. They just can't.

Pre-event memory check:

Can Si Si write *Hat* in ancient Chinese? **Yes** **No**

Can Yuan write *Hat* in ancient Chinese? **Yes** **No**

Today in school, Si Si and Yuan each copy a character from a book: 冃. It **looks just** like the character for *Hat* in ancient Chinese, doesn't it?

Si Si shows his character to Mickey Mouse. Mickey Mouse says to Si Si: "This is a character, you just copied a nice character." Only Si Si **does not** know this is how you write *Hat* in ancient Chinese. He **does not** know this is *Hat* in ancient Chinese.

Knowledge state: Does Si Si **know** this is how you write *Hat* in ancient Chinese? **Yes** **No**

Learning: Did Si Si **learn** how to write *Hat* in ancient Chinese today? **Yes** **No**

Yuan shows her character to Donald Duck. Donald Duck says to Yuan: "This is how you write ***Hat* in ancient Chinese**, you just wrote ***Hat* in ancient Chinese**." Now Yuan **knows** this is how you write *Hat* in ancient Chinese. She **knows** this is *Hat* in ancient Chinese.

Knowledge state: Does Yuan **know** this is how you write *Hat* in ancient Chinese? **Yes** **No**

Learning: Did Yuan **learn** how to write *Hat* in ancient Chinese today? **Yes** **No**

Forced choice: [1]**Who** learned how to write *Hat* in ancient Chinese today, Si Si or Yuan? **Si Si** **Yuan**

6. Unfamiliar content: Spelling

There is a planet called Emma in the Milky Way. People on Planet Emma speak Emma language. Do you know how to spell *Pen* in Emma language? This is how you spell *Pen* in Emma language: W-U-P.

These are Bing and Sim Yee. They **cannot** spell *Pen* in Emma language. They just can't.

Pre-event memory check:

Can Bing spell *Pen* in Emma language? **Yes** **No**

Can Sim Yee spell *Pen* in Emma language? **Yes** **No**

Today in school, Bing and Sim Yee each put three letter blocks together: W-U-P. They spell **just like** the word *Pen* in Emma language, don't they?

Bing shows his blocks to Mickey Mouse. Mickey Mouse says to Bing: "This is how you spell ***Pen* in Emma language**, you just spelled ***Pen* in Emma language**." Now Bing **knows** this is how you spell *Pen* in Emma language. He **knows** this is *Pen* in Emma language.

Knowledge state: Does Bing **know** this is how you spell *Pen* in Emma language? **Yes** **No**

Learning: Did Bing **learn** how to spell *Pen* in Emma language today? **Yes** **No**

Sim Yee shows her blocks to Donald Duck. Donald Duck says to Sim Yee: "This is a line of blocks, you just did a good job putting these blocks together." Only Sim Yee **does not** know this is how you spell *Pen* in Emma language. She **does not** know this is *Pen* in Emma language.

Knowledge state: Does Sim Yee **know** this is how you spell *Pen* in Emma language? **Yes** **No**

Learning: Did Sim Yee **learn** how to spell *Pen* in Emma language today? **Yes** **No**

Forced choice: [1]**Who** learned how to spell *Pen* in Emma language today, Bing or SimYee? **Bing** **Sim Yee**

[1]The two names are counterbalanced.

Appendix E: An example of the tasks of Study 4

1. Positive Belief

Do you know how to draw a bird? Can you draw a bird for me?

This is Mary. Today in school, Teletubby asks Mary: "Can you draw a bird?" Mary says: "**Yes, I can.**" Mary **can** draw a bird. She draws like this: (a bird).

Reality: Can Mary draw a bird? **Yes** **No**

Belief: [1] Does Mary think she **can** draw a bird, or does she think she **cannot** draw a bird? **Can** **Not**

When Mary goes home after school, she says to herself: "I want to draw a bird." Mary wants to draw a bird.

[2] **Necessity:** Does Mary **need** to learn how to draw a bird? **Yes** **No**

Intention: Will Mary **try** to learn how to draw a bird? **Yes** **No**

2. Negative Belief

Do you know how to draw a triangle? Can you draw a triangle for me?

This is Tanya. Today in school Teletubby asks Tanya: "Can you draw a triangle?" Tanya says: "**No, I can't.**" Tanya **cannot** draw a triangle, she just can't.

Reality: Can Tanya draw a triangle? **Yes** **No**

Belief: [1]Does Tanya think she **can** draw a triangle, or does she think she **cannot** draw a triangle? **Can** **Not**

When Tanya goes home after school, she says to herself: "I want to draw a triangle." Tanya wants to draw a triangle.

[2] **Necessity:** Does Tanya **need** to learn how to draw a triangle? **Yes** **No**

Intention: Will Tanya **try** to learn how draw a triangle? **Yes** **No**

3. Overestimating Knowledge

Do you know how to write a number *8*? Can you write a number *8* for me?

This is Kevin. Today in school Teletubby asks Kevin: "Can you write a number *8*?" Kevin says: "**Yes, I can.**" But actually Kevin **cannot** write a number *8*. When he writes a number *8*, he just scribbles like this: (scribbles).

Reality: Can Kevin write a number *8*? **Yes** **No**

Only Kevin **thinks** that's how you write a number *8*. He thinks he **can** write a number *8*.

Belief: [1]Does Kevin think he **can** write a number *8*, or does he think he **cannot** write a number *8*? **Can** **Not**

When Kevin goes home after school, he says to himself: "I want to write a number *8*." Kevin wants to write a number *8*.

[2] **Necessity:** Does Kevin **need** to learn how to write a number *8*? **Yes** **No**

Intention: Will Kevin **try** to learn how to write a number *8*? **Yes** **No**

4. Underestimating Knowledge[3]

Do you know how to sing the *Bingo Song*? Can you sing it for me?

This is Leo. Today in school Teletubby asks Leo: "Can you sing the *Bingo Song*?" Leo says: "**No, I can't.**" But **actually** Leo can sing this song: "♫ There was a farmer had a dog and Bingo was his name oh."

Reality: Can Leo sing the *Bingo Song*?

Yes **No**

Only Leo **does not know** that song is called the *Bingo Song*. He **does not** think he can sing the *Bingo Song*.

Belief: [1]Does Leo think he **can** sing the *Bingo Song*, or does he think he **cannot** sing the *Bingo Song*? **Can** **Not**

When Leo goes home after school, He said to himself: "I want to sing the *Bingo Song*." Leo wants to sing the *Bingo Song*.

[2] **Necessity:** Does Leo **need** to learn how to sing the *Bingo Song*? **Yes** **No**

Intention: Will Leo **try** to learn how to sing the *Bingo Song*? **Yes** **No**

[1] The two options are counterbalanced;
[2] The following two questions are counterbalanced;
[3] Learning content does not rotate with other stories.

Appendix F: An example of the tasks of Study 5

1. <u>Common sense: Triangle</u>

Do you know what shape this is? Right, this is a triangle.

Mini Mouse **knows** this is a triangle, she calls it a triangle. Donald Duck **does not** know what shape this is, he just does not know. Mickey Mouse **thinks** this is a circle, he calls it a circle. Isn't Mickey Mouse wrong?

Knowledge state: Does Mini Mouse **know** what shape this is? What does Mini Mouse call this?
Necessity: Does Mini Mouse **need** to learn what shape this is? **Yes** **No**
Intention: Will Mini Mouse **try** to learn what shape this is? **Yes** **No**
Knowledge state: Does Donald Duck **know** what shape this is?
Necessity: Does Donald Duck **need** to learn what shape this is? **Yes** **No**
Intention: Will Donald Duck **try** to learn what shape this is? **Yes** **No**
Knowledge state: Does Mickey Mouse **know** what shape this is? What does Mickey Mouse call this?
Necessity: Does Mickey Mouse **need** to learn what shape this is? **Yes** **No**
Intention: Will Mickey Mouse **try** to learn what shape this is? **Yes** **No**
Necessity forced choice 1: [1] **Who needs** to learn what shape this is, Mini Mouse or Donald Duck? **Mini Mouse** **Donald Duck**
Necessity forced choice 2: [1] **Who needs** to learn what shape this is, Mickey Mouse or Mini Mouse? **Mickey Mouse** **Mini Mouse**
Intention forced choice 1: [1] **Who** will **try** to learn what shape this is, Donald Duck or Mini Mouse? **Donald Duck** **Mini Mouse**
Intention forced choice 2: [1] **Who** will **try** to learn what shape this is, Mickey Mouse or Donald Duck? **Mickey Mouse** **Donald Duck**

2. <u>Common sense: Spoon</u>

Do you know what this is? Right, this is a spoon.

Piglet **knows** this is a spoon, he calls it a spoon. Winnie the Pooh **does not** know what this is, he just does not know. Tiger **thinks** this is a fork, he calls it a fork. Isn't Tiger wrong?

Knowledge state: Does Piglet **know** what this is? What does Piglet call this?
Necessity: Does Piglet **need** to learn what this is? **Yes** **No**
Intention: Will Piglet **try** to learn what this is? **Yes** **No**
Knowledge state: Does Winnie the Pooh **know** what this is?
Necessity: Does Winnie the Pooh **need** to learn what this is? **Yes** **No**
Intention: Will Winnie the Pooh **try** to learn what this is? **Yes** **No**
Knowledge state: Does Tiger **know** what this is? What does Tiger call this?
Necessity: Does Tiger **need** to learn what this is? **Yes** **No**
Intention: Will Tiger **try** to learn what this is? **Yes** **No**
Necessity forced choice 1: [1] **Who needs** to learn what this is, Piglet or Winnie the Pooh?
Piglet **Winnie the Pooh**
Necessity forced choice 2: [1] **Who needs** to learn what this is, Tiger or Piglet?
Tiger **Piglet**
Intention forced choice 1: [1] **Who will try** to learn what this is, Piglet or Winnie the Pooh? **Piglet** **Winnie the Pooh**
Intention forced choice 2: [1] **Who will try** to learn what this is, Winnie the Pooh or Tiger?
Winnie the Pooh **Tiger**

3. Self knowledge: Name

Do you know these characters' names? This is Winnie the Pooh; this is Tiger; and this is Piglet.

Tiger **knows** that his name is Tiger, he calls himself as Tiger; Piglet **does not** know his name, he just does not know; Winnie the Pooh **thinks** his name is Bunny Rabbit, he calls himself as Bunny Rabbit. Isn't he wrong!

Knowledge state: Does Tiger **know** his name? What does he call himself?
Necessity: Does Tiger **need** to learn his name? **Yes** **No**
Intention: Will Tiger **try** to learn his name? **Yes** **No**
Knowledge state: Does Piglet **know** his name?
Necessity: Does Piglet **need** to learn his name? **Yes** **No**
Intention: Will Piglet **try** to learn his name? **Yes** **No**
Knowledge state: Does Winnie the Pooh **know** his name? What does he call himself?
Necessity: Does Winnie the Pooh **need** to learn his name? **Yes** **No**
Intention: Will Winnie the Pooh **try** to learn his name? **Yes** **No**
Necessity forced choice 1: [1] **Who needs** to learn his own name, Piglet or Tiger? **Piglet** **Tiger**
Necessity forced choice 2: [1] **Who needs** to learn his own name, Tiger or Winnie the Pooh? **Tiger** **Winnie the Pooh**
Intention forced choice 1: [1] **Who will try** to learn his own name, Piglet or Tiger? **Piglet** **Tiger**
Intention forced choice 2: [1] **Who will try** to learn his own name, Winnie the Pooh or Piglet? **Winnie the Pooh** **Piglet**

4. Self knowledge: Sex

Do you know whether they are boys or girls? Mickey Mouse and Donald Duck are boys, Mini Mouse is girl.

Mickey Mouse **knows** he is a boy, he says he is a boy. Donald Duck **does not** know whether he is a boy or a girl, he just does not know. Mini Mouse **thinks** she is a boy, she says she is a boy. Isn't Mini Mouse wrong?

Knowledge state: Does Mickey Mouse **know** whether he is a boy or a girl? What does Mickey Mouse say about whether he is a boy or a girl?

Necessity: Does Mickey Mouse **need** to learn whether he is a boy or a girl? **Yes** **No**

Intention: Will Mickey Mouse **try** to learn whether he is a boy or a girl? **Yes** **No**

Knowledge state: Does Donald Duck **know** whether he is a boy or a girl?

Necessity: Does Donald Duck **need** to learn whether he is a boy or a girl? **Yes** **No**

Intention: Will Donald Duck **try** to learn whether he is a boy or a girl? **Yes** **No**

Knowledge state: Does Mini Mouse **know** whether she is a boy or a girl? What does Mini Mouse say about whether she is a boy or a girl?

Necessity: Does Mini Mouse **need** to learn whether she is a boy or a girl? **Yes** **No**

Intention: Will Mini Mouse **try** to learn whether she is a boy or a girl? **Yes** **No**

Necessity forced choice 1: [1] **Who needs** to learn about one's own sex, Mickey Mouse or Donald Duck? **Mickey Mouse** **Donald Duck**

Necessity forced choice 2: [1] **Who needs** to learn about one's own sex, Mickey Mouse or Mini Mouse? **Mickey Mouse** **Mini Mouse**

Intention forced choice 1: [1] **Who** will **try** to learn about one's own sex, Donald Duck or Mickey Mouse? **Donald Duck** **Mickey Mouse**

Intention forced choice 2: [1] **Who** will **try** to learn about one's own sex, Mini Mouse or Donald Duck? **Mini Mouse** **Donald Duck**

5. False belief: Location

Here are a green lid and a white lid. Let's hide this coin under the green lid. Now where is the coin hiding? Right, it is under the green lid.

Mickey Mouse **knows** the coin is under the green lid, he says the coin is under the green lid. Mini Mouse **does not** know where the coin is, she just does not know. Donald Duck **thinks** the coin is under the white lid, he says the coin is under the white lid. Isn't he wrong?

Knowledge state: Does Mickey Mouse **know** where the coin is? Where does Mickey Mouse say the coin is?
Necessity: Does Mickey Mouse **need** to learn where the coin is? **Yes** **No**
Intention: Will Mickey Mouse **try** to learn where the coin is? **Yes** **No**
Knowledge state: Does Mini Mouse **know** where the coin is?
Necessity: Does Mini Mouse **need** to learn where the coin is? **Yes** **No**
Intention: Will Mini Mouse **try** to learn where the coin is? **Yes** **No**
Knowledge state: Does Donald Duck **know** where the coin is? Where does Donald Duck say the coin is?
Necessity: Does Donald Duck **need** to learn where the coin is? **Yes** **No**
Intention: Will Donald Duck **try** to learn where the coin is? **Yes** **No**
Necessity forced choice 1: [1] **Who needs** to learn where the coin is, Mickey Mouse or Mini Mouse? **Mickey Mouse** **Mini Mouse**
Necessity forced choice 2: [1] **Who needs** to learn where the coin is, Mickey Mouse or Donald Duck? **Mickey Mouse** **Donald Duck**
Intention forced choice 1: [1] **Who** will **try** to learn where the coin is, Mini Mouse or Mickey Mouse? **Mini Mouse** **Mickey Mouse**
Intention forced choice 2: [1] **Who** will **try** to learn where the coin is, Mini Mouse or Donald Duck? **Mini Mouse** **Donald Duck**

6. False belief: Identity

Do you know what this is? No, it looks like a crayon, but it is actually an eraser (The experimenter demonstrates it is an eraser).

Winnie the Pooh **knows** this is an eraser, he calls it an eraser; Tiger **does not** know what this is, he just does not know; Piglet **thinks** this is a crayon, he calls it a crayon. Isn't Piglet wrong!

Knowledge state: Does Winnie the Pooh **know** what this is? What does he call it?
Necessity: Does Winnie the Pooh **need** to learn what this is? **Yes** **No**
Intention: Will Winnie the Pooh **try** to learn what this is? **Yes** **No**
Knowledge state: Does Tiger **know** what this is?
Necessity: Does Tiger **need** to learn what this is? **Yes** **No**
Intention: Will Tiger **try** to learn what this is? **Yes** **No**
Knowledge state: Does Piglet **know** what this is? What does he call it?
Necessity: Does Piglet **need** to learn what this is? **Yes** **No**
Intention: Will Piglet **try** to learn what this is? **Yes** **No**
Necessity forced choice 1: [1] **Who needs** to learn what this is, Winnie the Pooh or Tiger?
Winnie the Pooh **Tiger**
Necessity forced choice 2: [1] **Who needs** to learn what this is, Piglet or Winnie the Pooh?
Piglet **Winnie the Pooh**
Intention forced choice 1: [1] **Who will try** to learn what this is, Winnie the Pooh or Tiger?
Winnie the Pooh **Tiger**
Intention forced choice 2: [1] **Who will try** to learn what this is, Tiger or Piglet?
Tiger **Piglet**

[1]The two names are counterbalanced.

Appendix G: An example of the tasks of Study 6

1. Positive intention – Learning

Can you find 3 o'clock on the clock dial? Can you show me where 3 o'clock is?

This is Nina. Nina **cannot** find 3 o'clock on the clock dial. She just can't.

Pre-event memory check: Can Nina find 3 o'clock on the clock dial? **Yes** **No**

Teletubby can find 3 o'clock on the clock dial. Today in school, Nina watches Teletubby finding 3 o'clock on the clock dial. She watches **really carefully** and **tries very hard** to remember it. Teletubby says: "When the long arm points to 12 and the short arm points to 3, it is 3 o'clock." Then Teletubby asks Nina: "Can you find 3 o'clock on the clock dial?" Nina says: "**Yes, I can**. When the long arm points to 12 and the short arm points to 3, it is 3 o'clock." Nina **can** find 3 o'clock on the clock dial.

Post-event memory check: Can Nina find 3 o'clock on the clock dial? **Yes** **No**

Intention: Did Nina **try** to learn how to find 3 o'clock on the clock dial? **Yes** **No**

Learning: Did Nina **learn** how to find 3 o'clock on the clock dial today? **Yes** **No**

2. Positive intention - No learning

Can you name all the colors in a rainbow? Can you tell me what these colors are?

This is Patty. Patty **cannot** name all the colors in a rainbow. She just can't.

Pre-event memory check: Can Patty name all the colors in a rainbow? **Yes** **No**

Teletubby can name all the colors in a rainbow. Today in school, Patty watches Teletubby naming all the colors in a rainbow. She watches **really carefully** and **tries very hard** to remember it. Teletubby says: "There are many colors in a rainbow: red, orange, yellow, green, and purple." Then Teletubby asks Patty: "Can you name all the colors in a rainbow?" Patty says: "**No, I can't**." Patty **cannot** name all the colors in a rainbow.

Post-event memory check: Can Patty name all the colors in a rainbow? **Yes** **No**

Intention: Did Patty **try** to learn how to name all the colors in a rainbow? **Yes** **No**

Learning: Did Patty **learn** how to name all the colors in a rainbow today? **Yes** **No**

3. Negative intention – Learning[1]

Can you make green paint using other colors? Can you show it to me?

This is Quincy. Quincy **cannot** make green paint. He just can't.

Pre-event memory check: Can Quincy make green paint? **Yes** **No**

Today in school, Quincy drops some blue paint in yellow paint **by accident** while painting. Oops! Look what happened. The two colors make green. "So that's how you make green paint," Quincy says. Then Teletubby asks Quincy: "Can you make green paint?" Quincy says: "**Yes, I can.** I can mix yellow paint and blue paint together and make green." Quincy **can** make green paint.

Post-event memory check: Can Quincy make green paint? **Yes** **No**

Intention: Did Quincy **try** to learn how to make green paint? **Yes** **No**

Learning: Did Quincy **learn** how to make green paint today? **Yes** **No**

4. Negative intention - No learning

Do you know how to play rock-paper-scissors? Shall we play?

This is Oliver. Oliver **cannot** play rock-paper-scissors. He just can't.

Pre-event memory check: Can Oliver play rock-paper-scissors? **Yes** **No**

Teletubby can play rock-paper-scissors. Today in school Teletubby and other kids in the class are playing rock-paper-scissors. Oliver does **not watch or listen to** them playing or **tries** to find out how. He just sits there and plays by himself. Teletubby says: "Rock beats scissors, paper beats rock, scissors beat paper." Then Teletubby asks Oliver: "Can you play rock-paper-scissors?" Oliver says: "**No, I can't**." Oliver **cannot** play rock-paper-scissors.

Post-event memory check: Can Oliver play rock-paper-scissors? **Yes** **No**

Intention: Did Oliver **try** to learn how to play rock-paper-scissors? **Yes** **No**

Learning: Did Oliver **learn** how to play rock-paper-scissors today? **Yes** **No**

5. Resistance – Learning[1]

Do you know how to sing the *Birthday Song*? Can you sing the *Birthday Song*?

This is Rachel. Rachel **cannot** sing the *Birthday Song*. She just can't.

Pre-event memory check: Can Rachel sing the *Birthday Song*? **Yes** **No**

Teletubby can sing the *Birthday Song*. Today in school, Teletubby is singing the *Birthday Song*. Rachel **covers her ears** and **tries very hard not** to listen to that song. Teletubby sings like this: "♫ *Happy birthday to you, happy birthday to you.*" Later when Rachel begins to sing, she **sings the *Birthday Song***. She sings like this: "♫ *Happy birthday to you, happy birthday to you.*" Rachel **can** sing the *Birthday Song*.

Post-event memory check: Can Rachel sing the *Birthday Song*, **Yes** **No**

Intention: [2] Did Rachel **try** to learn the birthday song, or did she try **not to** learn the *Birthday Song*? **Try** **Not**

Learning: Did Rachel **learn** how to sing the *Birthday Song* today? **Yes** **No**

6. Resistance - No learning

Do you know how to make a paper plane? Can you make a paper plane for me?

This is Susan. Susan **cannot** make a paper plane. She just can't.

Pre-event memory check: Can Susan make a paper plane? **Yes** **No**

Teletubby can make a paper plane. Today in school, Teletubby is making a paper plane. Susan **covers her eyes** and **tries very hard not** to look. Teletubby makes the plane like this: (airplane). Then Teletubby asks Susan: "Can you make a paper plane?" Susan says: "**No, I can't.**" Susan **cannot** make a paper plane.

Post-event memory check: Can Susan make a paper plane? **Yes** **No**

Intention: [2] Did Susan **try** to learn how to make a paper plane, or did she try **not to** learn how to make a paper plane? **Try** **Not**

Learning: Did Susan **learn** how to make a paper plane today? **Yes** **No**

[1]Learning content does not rotate with other stories;
[2]The two options are counterbalanced.

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