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Preschoolers' understanding of the relationship between perceptual access and accuracy of knowledge: a study of 4- and 5-year-olds' judgments about model peers

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PRESCHOOLERS' UNDERSTANDING OF THE RELATIONSHIP BETWEEN PERCEPTUAL ACCESS AND ACCURACY OF KNOWLEDGE: A STUDY OF 4- AND 5-YEAR-OLDS' JUDGMENTS ABOUT PEER MODELS

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ABSTRACT

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Knowing the relationship between perceptual access and the accuracy of knowledge is a critical skill for acquiring accurate information directly or indirectly from another. Some informants are more reliable than others although careful attention must be paid to whether they have appropriate perceptual access in order to acquire accurate information. In this study, I explored whether 4- and 5-year-olds (N = 176) used their previous knowledge evaluations of two model peers and their own knowledge of where knowledge comes from to determine who to trust when acquiring indirect knowledge about physical objects. Older children were more successful in identifying which sensory organ they used when acquiring modality-specific knowledge but both older and younger children overestimated the use of their eyes. I also found that 4- and 5-year-olds evaluated a peer's knowledge based more on whether a peer was previously accurate and therefore reliable than on whether the peer had appropriate perceptual access to acquire accurate knowledge. Five-year-olds were more successful than 4-year-olds when evaluating peers' knowledge acquisition of modality-specific attributes of physical objects. Regardless of age, children were more successful in determining whom to learn from when the peer that was previously reliable also had appropriate perceptual access than when the peer that was previously reliable did not have appropriate perceptual

access to acquire knowledge about physical objects. These findings expand upon previous research in a number of ways, most importantly by showing that children's tracking ability of a peer's accuracy is quite strong and the results of the peer's track record is a more important guide in determining whom to learn from than whether a peer has appropriate perceptual access. Also, the results of this study extend others' evidence that children overestimate the value of sight when asked how modality-specific knowledge was acquired.

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It seems that an expression of gratitude to the many families of children and adolescents with autism is an understatement for all that you have taught me. I am humbled in your presence. Your children have inspired me to sincerely appreciate the complexity of cognitive and social-cognitive development. This dissertation is dedicated to you.

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CHAPTER I

INTRODUCTION

Beginning in the first year of life, we seem to effortlessly acquire new knowledge, both directly and from other people (Bandura, 1986; Bruner, 1996; Vygotsky, 1978). For example, children in preschool who are curious as to whether today's snack is going to be the gross celery sticks given out yesterday or the yummy cookies from last week can simply ask their teacher or look at the snack supplies to find out if the celery bag or cookie box is present. This relatively advanced ability in acquiring new knowledge is in stark contrast to young children's impaired ability in understanding *how* they acquired this new information (Gopnik & Graf, 1988; O'Neill, Astington, & Flavell, 1992; Taylor, Esbensen, & Bennett, 1994). It is not until the preschool years that children begin to understand that much knowledge about tangible items is based upon direct perception of the items (Chandler & Helm, 1984; Cooper, 2007; Norton, 2003; O'Neill et al.; Taylor, 1996; Wimmer, Hogrefe, & Sodian, 1988). This study explored 4- and 5-year-old children's ability to evaluate the accuracy of two model peers' knowledge as a function of their understanding of how knowledge is acquired. Given the still-emerging understanding about the origins of knowledge, I expected that when faced with conflicting secondhand information about a tangible item, younger preschoolers would be more likely to evaluate an informant based on the informant's previous reliability rather than the informant's ability to access accurate information. In contrast, I expected that older preschoolers would be more likely to ignore the informant's previous reliability and accurately evaluate the informant's ability to access accurate information about a tangible item.

Adults are remarkably efficient in determining the most optimal way to acquire valid knowledge, an ability which is essential to everyday functioning. For example, I can quickly consider various ways in to determine the contents of a wrapped present given to me on my birthday. I may directly acquire such knowledge by opening the gift and looking inside or indirectly by asking the person who gave it to me. I may be so eager to find out for myself and therefore only consider direct ways such as by opening the gift and looking at it or perhaps shaking it and drawing a conclusion based on its weight and the sounds resulting from the shake. Or I may have to wait to acquire the knowledge directly and may be restricted to asking others. In this case, I would likely ask the person who gave it to me rather than someone else at the party. Adults are able to consider both direct and indirect routes that will likely lead to accurate knowledge about the identity of hidden objects.

The accuracy of knowledge that results from others can be challenging to evaluate. To learn from another is to trust that the person's knowledge is accurate and therefore the person is trustworthy. As adults, we can be quite selective in whom we trust in specific situations. For example, when attempting to acquire information about an event, we are more likely to trust a person who attended the event as opposed to a person who did not attend the event. We may question the integrity of the politician running for office or the defendant on trial based on their previous behavior. Human beings would not have adapted well if we simply believed everything that others told us (Thierry, Spence, & Memon, 2001).

Statement of the Problem

It is generally efficient to acquire knowledge from others, but the accuracy may be compromised depending on who is offering the information. For example, a child participating in a cooperative learning activity may need to monitor how fellow participants acquire their expertise in order to evaluate the accuracy of their contribution and therefore to determine whether to accept their perspective or disregard it. In other cases, peers' assertions may be based on previously acquired knowledge, which is not accessible for monitoring. For example, a peer may propose to use markers in the art center because all of the crayons in the box are broken or to listen to a different song in the music center because the current compact disc skips, which were both discovered earlier in the day. Although these assertions could be verified by looking in the crayon box or listening to the compact disc, there are cases in which the child must rely upon peers' knowledge without the ability to directly verify. This study employed a unique methodology in order to study young children's evaluations of others' knowledge by monitoring how they acquire this new knowledge.

If preschoolers uncritically accept others' assertions as true, this bias can lead to a host of potentially negative outcomes (Thierry, Spence, & Memon, 2001). For example, a child may become embarrassed following a declaration of a misconception that was offered from a person thought to be trustworthy. In more extreme circumstances, if a child trusts a peer's assertion that his father's gun is safe to handle and in fact, it is not, a deadly outcome may result. In a recent comprehensive review of the social cognition development literature, Harris indicated that "for the most part, investigators have neglected a domain in which children's social cognition is likely to have far-reaching implications: their credulity with respect to other people's claims" (Harris, 2006, p. 848). Children's ability to assess the integrity of others' assertions and their ability to assess the integrity of assertions offered by similar-age peers have not been studied systematically to date.

Children's evaluations of others' knowledge may be based on their beliefs about the relationship between people and knowledge. It is unclear whether 4- and 5-year-old children believe that if an individual has been historically accurate, the individual can always be trusted in the future or alternatively that an individual's knowledge is variable. If children believe in the former, they will adopt assertions offered by a previously reliable peer but if children believe in the latter, they will ignore peers' previous reliability and adopt assertions offered by the peer who currently has acquired valid knowledge (Miller, 2000). This study investigated children's evaluation of model peers' knowledge by employing a method that systematically manipulated the accuracy of models' testimony.

In order to evaluate others' knowledge, children must consider whether the knowledge-gathering procedure would appropriately lead to accurate knowledge. Four-year-old children are just beginning to understand the role that perceptual access has on the integrity of knowledge acquired (Taylor, 1996). For example, to trust a peer's assertion that the compact disc skips is to believe that the peer recently heard the disc skip or that the peer was told by a reliable source. The cognitive mechanisms through which preschoolers access and assess another's knowledge are not fully clear (Harris, 2006; Hofer & Pintrich, 1997).

Much of the research on children's developing understanding of knowledge is based on experimental tasks that require children to consider the knowledge of an adult or an inanimate object (e.g., a doll). This is not particularly reflective of the social dynamic or the social cognitive expectations that these young children would otherwise face in a typical learning setting such as the preschool classroom. This study used two model peers of similar age to the participants in order to improve upon the ecological validity of previous research.

Rationale for the Study

Preschoolers' evaluations of others' knowledge are based in part on their emerging understandings about people. From infancy, children display complex and rather coherent representations of various aspects of the mental world (Gopnik, Meltzoff, & Kuhl, 1999). Infants pay careful attention to others (Stern, 1985) and understand others as "like me" and therefore the self as like others (Meltzoff & Moore, 1998). Children and adults learn many behaviors, thought patterns, and skills by observing other people (Bandura, 1986), an ability that is likely based on an understanding of the social world.

Regardless of whether knowledge is acquired directly or indirectly from others, infants and toddlers acquire knowledge readily but do not understand how that knowledge is acquired. In fact, even 3-year-olds often have difficulty in identifying the source of their knowledge (Gopnik & Graf, 1988; Perner & Ruffman, 1995; Povinelli &

deBlois, 1992; Taylor et al., 1994; Whitcombe & Robinson, 2000; Wimmer, Hogrefe, & Perner, 1988).

Children's developing understanding of knowledge has historically been studied as an aspect of their theory of mind. Young children's theory of mind refers to their theory-like conceptualization of mental states. By 4 or 5 years of age, children base their predictions, explanations, and overall understanding of human behavior on non-observable constructs such as desires and beliefs (Gopnik & Wellman, 1994). Young children's understanding of knowledge may develop along with their understanding of beliefs and the distinctions between appearance and reality (Moore & Furrow, 1991). Also by 4 or 5 years of age, children appreciate that to "know" implies more certainty than to "think" or to "guess" and that knowing reflects an accurate understanding of reality (Montgomery, 1992; Moore, Bryant, & Furrow, 1989; Moore & Furrow, 1991). Beginning around age 4, children begin to appreciate the causal origins of knowledge (Wimmer et al., 1988). During this time, children begin to understand that knowledge about characteristics of an object will vary based on the sensory organ employed (O'Neill et al., 1992; Pillow, 1993). There are times, however, when children wrongly attribute knowledge to an individual without perceptual access and wrongly deny knowledge to an individual with appropriate perceptual access (Cooper, 2007; Taylor, 1996).

Theoretical Framework

The study of knowledge, or epistemology, has a long history that has led to the development of multiple theories of the nature of knowledge (Fitzgerald & Cunningham, 2002). This study emphasized the theories that indicate that knowledge results directly from one's subjective experience and indirectly by accessing another's firsthand subjective experience, such as by hearing another's testimony.

A mature theory of mind includes an understanding of how knowledge develops. Between 4 and 6 years of age, children are increasingly more able to report on whether they acquired knowledge directly or indirectly from another (Drummey & Newcombe, 2002). During this time, children also begin to evaluate whether another's knowledge is accurate. When learning the label of novel objects, 4-year-olds correctly subscribed to the testimony of the previously accurate informant (Birch, Vauthier, & Bloom, 2008; Clément, Koenig, & Harris, 2004; Jaswal & Neely, 2006; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007).

Albert Bandura's social cognitive theory (1986) and Lev Vygotsky's sociocultural theory of cognitive development (1978) highlight the influences of the social environment on knowledge acquisition. Children and adults alike construct knowledge based on socially mediated experiences (Bruner, 1996). This study was framed by the notion that much of children's cognitive development takes place in a social context. More specifically, there are interrelationships among a child's thoughts, his learning behavior, and his interpretations of others' learning behaviors (Bandura, 1986).

The social environment clearly has an effect on children's developing understanding of mental states (Astington, 1996; Dunn, 1996; Perner, Ruffman, & Leekam, 1994). Young children actively construct their own knowledge and contribute to others' knowledge construction just as others' constructed knowledge mediates learning in a socially dynamic way. Children benefit from a family environment comprised of people that highlight the role that mental states have on behavior and the fact that mental states are unique to individuals. Family conversations that are marked by mental state speech are an aspect of the social context known to be related to children's understanding of mental states (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991).

Purpose

The purpose of the study was to add to the literature on children's understanding of knowledge. It was unclear whether preschoolers would choose to trust in the information offered by a peer who was previously reliable or by a peer whose knowledge was currently valid. This study was designed to investigate such choices in 4- and 5-year-old children based on their understanding of how modality-specific knowledge (i.e., knowledge based on seeing, hearing, touching, tasting, or smelling) is acquired. Children's understanding of each of the sensory modalities was assessed to determine whether there are developmental differences in understanding the source of knowledge depending on the modality.

Research Questions and Hypotheses

Q1 What are the differences between 4- and 5-year-olds' understandings of knowledge about physical objects?

H1 Three- and 4-year-olds are able to evaluate the accuracy of two informants (Birch, Vauthier, & Bloom, 2008; Clément et al., 2004; Jaswal & Neely, 2006; Koenig, Clément, & Harris, 2004; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007). After directly acquiring knowledge and then watching others acquire knowledge, there will be no significant difference between 4- and 5-year-olds' ability in evaluating the validity of others' knowledge.

H2 When learning the label of novel objects, 4-year-olds correctly subscribe to the testimony of a previously accurate informant (Clément et al., 2004; Jaswal & Neely, 2006; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007). Therefore, I predicted that 4-year-olds will be significantly more likely than 5-year-olds to subscribe to the testimony offered by the model peer that was previously accurate, regardless of this model peer's access to modality-specific knowledge. This expectation implies that initial reliability will overshadow later competency.

H3 Children's understanding of the relationship between appropriate perceptual access and knowledge improves between 4 and 5 years of age (Chandler & Helm, 1984; Norton, 2003; O'Neill, Astington, & Flavell, 1992; Taylor, 1988). Therefore, I predicted that 5-year-olds will be significantly more likely than 4-year-olds to choose the answers offered by the model peer that has adequate perceptual access, regardless of this model peer's previous reliability. This implies that 5-year-olds will be able to accurately assess knowledge-seeking behavior while ignoring their previous impressions of peer competency.

Q2 What knowledge is related to children's understanding of knowledge about physical objects?

H1 Children's ability to identify the source of their knowledge improves significantly between 4 and six years of age (Drummey & Newcombe, 2002; Gopnik & Graf, 1988). Therefore, children who explicitly know which sensory organ was the source of their own modality-specific knowledge will be more successful in assessing another's modality-specific knowledge acquisition than children who do not know the source of their knowledge.

Q3 Are there differences in children's understanding of how knowledge about physical objects is acquired based on the modality?

H1 Four-year-olds have been found to be more successful in understanding the source of visual-specific knowledge than other modality-specific sources of knowledge (Gopnik & Graf, 1988; Norton, 2003; O'Neill & Gopnik, 1991; Weinberger & Bushnell, 1994; Wimmer, Hogrefe, & Perner, 1988). I predicted that children will be more successful in evaluating the accuracy of visual-specific knowledge than auditory-specific tactile-specific, tactile-specific, olfactory-specific, and gustatory-specific knowledge.

H2 Children have been found to overestimate the knowledge acquired through sight (Cooper, 2007; Fabes & Filsinger, 1986; Robinson, Thomas, Parton, & Nye, 1997; Weinberger & Bushnell, 1994). Therefore, I predicted that children will overestimate the power of another's sight when attempting to acquire non-visual-specific knowledge. In turn, children will falsely attribute knowledge to another when the other person has irrelevant visual access. Children will engage in a simple heuristic in which seeing is knowing, so not seeing is not knowing, regardless of the type of knowledge.

Limitations

One limitation of the study is related to the use of model peers. The methodology is designed to simulate a typical observational learning experience that preschoolers may face but was modified to control for characteristics of the peers which may contribute to unwanted response patterns of the participants. For example, if true peers were used who were well liked and well known by some of the participants, then participants may evaluate the peers' knowledge differently from participants who did not know the peers or who did not like the peers. Therefore the model peers were unknown to the participants and their behaviors were standardized.

Another limitation was that superficial characteristics of the models may impact participants' evaluations of the models. For example, children tend to learn more from those who are more similar to them and from those who have qualities that children admire (Bandura, 1986). Rather than evaluating the model's knowledge, participants may evaluate models based on physical traits such as similar hair color to their own or athletic appearance.

Although the behaviors of the models were standardized, there may be slight differences that affect participants' interpretations of the models' competence. For example, preschoolers trust those who speak with confidence over those who speak with less certainty (Jaswal & Malone, 2007; Sabbagh & Baldwin, 2001). Therefore, participants may have evaluated the models' knowledge based more on the models' speech tone and mannerisms (e.g., confident vs. uncertain) rather than the content of the models' testimony.

Even though the models were described to participants as “kids like you that have never seen these things before,” participants may have inferred that the incorrect model is joking or deceitful. If so, participants may have concluded that the incorrect model was intentionally offering wrong information; therefore, participants may not have paid attention to the incorrect model’s behavior, such as his knowledge gathering procedure.

There is a selection bias in that only children enrolled in a preschool participated in this study. In the United States, almost 69% of 4-year-olds and 86% of 5-year-olds participate in early education programs (National Center for Education Statistics, 2007). Children who participate in preschool seem to be better prepared for future schooling. In fact, the variability in children’s participation in preschool programs has been thought to partially account for the individual differences in kindergartner’s ability to learn, talk, or even listen (Morrison, Griffith, & Alberts, 1997). Therefore, the performance of the sample may not be reflective of 4- and 5-year-olds who do not attend preschool.

Definition of Terms

Deception- an individual’s intentful act to instill a false belief in another’s mind

Epistemic beliefs- representations about the nature, organization, and sources of knowledge, its truth value, and justification criteria of assertions (Hofer & Pintrich, 1997)

Epistemic trust- reliance upon a source (e.g., written documentation, verbal testimony) based on the belief that the documentation or testimony is valid

Epistemology- the study of the nature of knowledge and the process of how knowledge is acquired, represented, and justified

False Belief- mental state in which representations existing in the mind do not match external reality

Intersubjectivity- the sharing of two individuals' subjective experiences

Knowledge- a true belief is qualified as knowledge when there is evidence to support it and because the belief is based on that evidence (Dretske, 1981)

Mental Representations- internal constructs of something as being a certain way

Mental States- beliefs/thoughts, desires/wants, and emotions/feelings

Metacognition- awareness of the cognitive processing of self and others

Model Competency Phase- the first part of the method in this investigation in which participants acquire modality-specific knowledge and then determine whether the models are reliable based on the modality-specific knowledge each offers

Modality-specific knowledge- mental representation of sensory characteristics of an object or an object's identity based on sensory understanding of the object

Observational Learning- attention to and representation of another's behavior in order to acquire basic understandings

Source Monitoring- the ability to identify the origin of knowledge

Testimony- an assertion offering firsthand authentication of a fact

Testing Phase- the second part of the method in this investigation in which participants evaluate whether the models' knowledge acquisition procedures are valid

Theory of Mind- an implicit mental framework which is used to guide individuals' ability to predict and explain their own or another's behavior based on the person's thoughts or emotions. Based on this framework, individuals appreciate that their minds are separate from another's mind. The understanding that the mental world is distinctive from the physical world is another component of one's theory of mind.

Trust- belief that a person's knowledge is accurate

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of this chapter is to provide an overview of the current research on preschoolers' developing understanding of knowledge. The study is based on theories in which knowledge results from socially mediated experiences. Therefore, the social origin of knowledge is described, and observational learning research is reviewed. Given the developmental nature of children's understanding of knowledge, it is necessary to highlight the early aspects of mental state understanding that develop during infancy and the toddler years and lay the foundation for preschoolers' emerging understanding of knowledge. The existing literature on preschoolers' understanding of how knowledge is acquired is also reviewed.

The literature review highlights three limitations of existing research: (a) previous studies have not assessed young children's understanding of knowledge in an observational learning paradigm; (b) few studies have comprehensively assessed all sources of modality-specific knowledge or examined potential differences in understanding sources of knowledge; (c) previous studies of preschoolers' understanding of mental states have asked participants to consider an adult's or puppet's mental states as opposed to other, similar age preschoolers; and (d) no research has systematically manipulated the accuracy of others' modality-specific knowledge.

Social Origins of Cognitive Development

Well before children enter the preschool classroom, they have been actively constructing a framework of how the mental and physical worlds operate in synchrony. Prior to beginning school, they have been learning by observing how their parents, other caregivers, siblings, and peers acquire information about the physical world. Therefore, others contribute to children's developing understanding of how knowledge is acquired. As infants and toddlers observe and imitate others, learn about emotions, build their social-communicative competence, and develop an overall social understanding, they acquire a foundation that allows them to appreciate the origins of their own and others' mental states (e.g., beliefs, knowledge, emotions; Wellman, 1990).

Albert Bandura's social cognitive theory (1986) and Lev Vygotsky's sociocultural theory of cognitive development (1978) highlight the importance of the social environment for learning. Interestingly, both theories are rarely discussed in the context of children's developing understanding of mental states, yet they offer unique and important contributions to this topic. A third theory, Jerome Bruner's (1996) models of the mind, will also be reviewed. This theory has been explicitly connected to a child's developing theory of mind.

Bandura's Social Cognitive Theory

Bandura's social cognitive theory was primarily influenced by Miller and Dollard (1941). In 1941, Miller and Dollard proposed a theory of social learning that highlighted the role of reinforcement on imitated behaviors. A model displaying a particular behavior was viewed as a stimulus eliciting an imitative response by the observer who is then reinforced. In essence, learning will occur if the individual is reinforced for imitating the behavior. Bandura expanded on this theory to better account for the higher-order cognitive processing that is required when an individual learns from another.

Similar to Wellman's (1990) model of belief-desire reasoning described briefly in Chapter 1 and more thoroughly in a future section in this chapter, Bandura (1986) proposed a complex model of the relationship between cognition and behavior. However, Bandura's social cognitive theory includes an interactive component of the environment that Wellman's model does not account for. Bandura claims that there is a multi-dimensional interaction among children's personal characteristics (e.g., gender, age, social status) including their internal states (e.g., thoughts and emotions), their observable behaviors, and their perceptions of others' actions and other aspects of the external environment. Bandura refers to this bidirectional interaction between the child and the environment as reciprocal determinism, with the child determining how others respond to him or her as much as how the child responds to others.

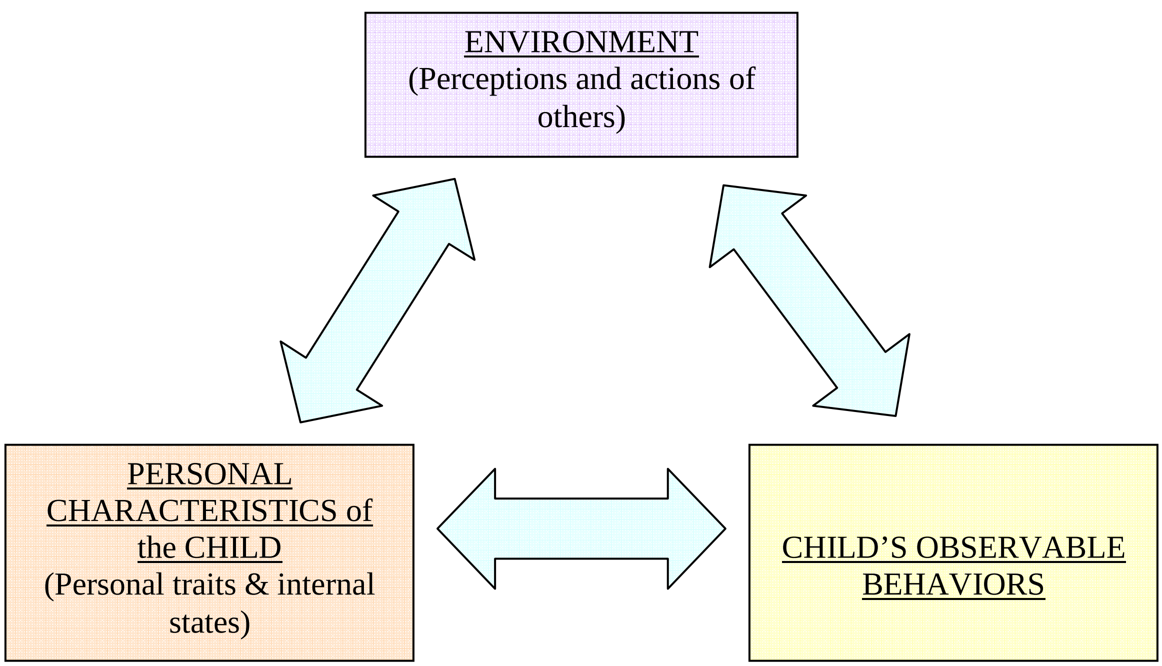


Figure 1. Bandura's Reciprocal Determinism Model.

Wellman suggests that a child explains and predicts what another does based on another's beliefs and desires. Bandura's model is broader than Wellman's model and accounts for the social complexity of the environment in which people act. Bandura claims that beliefs and desires cause behavior, and this behavior influences the actor's cognitions and others' cognitions, which in turn influences the actor's cognitions. Childrens' behaviors influence how other people in the environment perceive and act toward them, which will, of course, affect their thinking and behavior. The social world is dynamic and is comprised of actively constructed social relationships, which bear on the cognitions and behaviors of its members.

Vygotsky's Sociocultural Theory of Cognitive Development

"[Vygotsky] considered the capacity to teach and to benefit from instruction a fundamental attribute of human beings" (Moll, 1990, p. 1). He claimed that children teach and learn from each other. Vygotsky emphasized the social origins of thought in children's developing cognitions but he also recognized that there are multiple aspects of a child's being including genetic and cultural influences that interact and affect development.

One aspect of cognitive development is the transformation of basic infant mental functions such as attention and memory into higher mental functions. These higher order competencies are first socially mediated and then internalized. Members of the child's social environment such as parents, siblings, teachers, and peers influence this process of internalization. In a group learning environment such as preschool, particular tools of intellectual adaptation such as observational learning promote cognition. Observational learning allows children to benefit from their peers' expertise and in turn, to contribute to others' expertise. Vygotsky recognized that children do not internalize what they observe immediately. Vygotsky (1978) claimed that this "transformation of an interpersonal process into an intrapersonal one is the result of a long series of developmental events" (p. 57). At first, the action may be imperfectly imitated or its meaning not quite understood. Moreover, even after an action is internalized, its linkage to other internalized acts may take some time.

One of Vygotsky's greatest contributions may be the appreciation of the child's current understanding as compared to the child's potential for understanding with adequate support called the "zone of proximal development." Vygotsky referred to young children as apprentices whose cognitive development is stimulated by others. He claimed that "what children can do with the assistance of others might be in some sense even more indicative of their mental development than what they can do alone" (Vygotsky, 1978, p. 5).

Vygotsky's theory highlights the role that others have in influencing a child's cognitive development. The focus of this study is to assess children's understanding of the role that peers have on their knowledge. Peers, especially more knowledgeable peers, can positively influence children's cognition. Children must consider peers' mental states in order to ensure that the peers' expertise are relevant and accurate and ultimately conclude that the peer is trustworthy.

Bruner's Models of the Mind

Bruner (1996) highlighted four different popular "models of learners' minds" (p. 53). One model describes the student as an imitative learner. The more expert individual is required to consider the novice learner's current conceptual understanding, his or her theory of mind. A second model is one in which the learning of propositional knowledge is prioritized. Knowledge is considered to be objective and is learned from didactic exposure. The teacher presents facts to the student, and the student rather passively learns, remembers, and applies such knowledge. A third perspective is one that views the learner as balancing personal beliefs with knowledge that has been well scrutinized and stood the test of time. Children are viewed as managers of knowledge arising from multiple sources. This study focuses on the fourth perspective, depicted in the following statement: “Children, like adults, are seen as constructing a model of the world to aid them in construing their experience” (Bruner, 1996, p. 56). “Understanding is fostered through discussion and collaboration, with the child encouraged to express [his or] her own views better to achieve some meeting of minds with others who may have other views” (Bruner, 1996, p. 56). Classroom discourse, or the social exchange of ideas intended to enable the learner to construct knowledge, is clearly valued in this view.

Observational Learning

Children learn from others from an early age based in part on their imitative ability. The role of imitation has a long history in psychological theory. Over 100 years ago, Baldwin proposed a 3-stage theory of cognitive development built around the function of imitation in human development (Müller & Runions, 2003). Based on Baldwin’s theory, engaging in both simple and rather persistent imitative behaviors is the primary way in which people learn about the world including the social world (Zelazo & Lourenco, 2003). Learning by observing others’ behavior has influenced Bandura’s identification of the term, “observational learning”:

> Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others, one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action (Bandura, 1977, p. 22).

Many studies of observational learning have assessed people's ability to acquire new motor skills or modify existing motor skills (Bandura, 1986; Blandin, Lhuisset, & Proteau, 1999). Observational learning of motor behavior has been examined primarily with respect to the task, the model, and the observer characteristics. All three variables have been found to affect learning. Although motivation impacts the likelihood of learning after watching a demonstration of a skill, research has found that the main influence on learning is the scope of the behavior demonstrated (Downey, 1988).

Some studies have investigated the effectiveness of observational learning of academic subjects such as mathematics (Schunk, Hanson, & Cox, 1987), reading (Ezell & Justice, 2000; Horner, 2001, 2004), and writing (Schriver, 1992). In one such study, the effects of observational learning on preschoolers' pre-reading skill were studied. Children averaging 4.3 years of age were pre-tested on their pre-reading skills including alphabet recitation, capital letter identification, letter-word correspondence, and letter writing (Horner, 2001). In order to evaluate preschoolers' observational learning from a short videotaped alphabet book training between an adult and a child, the author randomly assigned participants to one of three groups. The alphabet book included a capital letter and a word beginning with that letter on one page and a picture representing the word on the other page. Compared to participants who observed a non-speaking model, participants who observed the child model asked questions during the lesson and were more likely to also ask questions during a similar alphabet lesson. After observing a model who specifically asked questions about the print displayed in the book, as opposed to questions about pictures or no questions, the preschool-age observers seemed to learn to pay attention to the print and were more likely to also comment about the print.

Precursors and Early Signs of Mental State Understanding During Infancy and the Toddler Years

The past twenty five years of research in development has demonstrated that even young infants already have abstract, complex, and rather coherent representations of various aspects of the mental world (Gopnik et al., 1999). Infants are social beings who pay careful attention to others likely because they find people to be both interesting and appealing (Stern, 1985). This early interest may facilitate infants' later development of a naïve psychology comprised of theories or beliefs about the relationship between themselves and other people and the relationship between the mental and physical worlds. This subjective-objective coordination underlies the development of epistemological thinking.

Early social cognitive understanding is evident in a number of surprisingly complex behaviors identified in empirical studies of young infants. The initial understandings of the first few months of life extend into later infancy and the toddler years. Early understanding of emotions, the development of imitation, and beginning social and social-communicative skills build the foundation for mental state understanding, which continues to develop during the preschool years.

Understanding Emotions

Emotion can be defined as “a subjective reaction to a salient event, characterized by physiological, experiential, and overt behavioral change” (Sroufe, 1996). Emotional development includes the expression of one’s emotions, the regulation of one’s emotions, recognition of others’ emotions, and one’s thinking of emotions. All such aspects relate to children’s developing mental state framework.

The social environment influences children’s understanding of emotions. The relationship between the infant and caregiver may be the earliest factor that promotes emotion understanding (Stern, 1985). The social dyadic interplay between an infant and caregiver is characterized by emotional reciprocity in which the two are simultaneously reinforcing each other to increase positive affective states. Simply acquiring emotional understanding based on behaviors that are reinforced, as in the case of operant conditioning, cannot fully account for how children *think* about emotions. In fact, children must have an understanding of emotion, including the causes of emotion, for optimal social-emotional development (Laible & Thompson, 2002). Brown and Dunn (1996) found that maternal discourse about emotion is linked with the development of emotional understanding. In addition, Harris (1994) has found that engagement in pretend play, which generally emerges in the toddler years, is also associated with more advanced understanding of mental states, including emotional states.

Children as young as 18 months relate the emotional expression of a third party to the object that another is referring to and regulate their own behavior based on the nature of a third party’s emotional expression (Repacholi & Meltzoff, 2007). By the second or third year, children’s accuracy in expression of emotions is related to their accuracy in interpreting others’ emotions (Magai &McFadden, 1995), which in turn likely contributes to their ability to successfully interact with peers in more complex social situations, including observational learning experiences.

Development of Imitation

Just as the underlying cognitive intentionality of a child’s emotional expression is analyzed, so too is the underlying intentionality of a young child’s imitative behavior. According to Piaget and some contemporary psychologists, true imitation is not simply reflexive but rather intentful and voluntary in which children mentally represent the behavior of another and then act out the behavior using their body (Bjorklund, 2000; Piaget, 1962). Infants can learn new behaviors through imitation beginning at approximately 8 to 12 months of age (Bjorklund, 2000). Learning by imitation is limited during this time and does not include behaviors that are wildly discrepant from the child’s existing schemes. With practice and as development continues, children’s imitative abilities become increasingly more precise and complex. Piaget claimed that children are not able to mentally represent until the second half of the second year. The ability to mentally represent is necessary in order to imitate a model’s behavior when the model is absent. Children can imitate after time has passed by retrieving the mental representation of another’s behavior from memory.

More recent evidence of imitative behavior in young infants seems to conflict with Piaget’s notions of the development of imitation. Interpreting the mentalistic nature of such early imitations is controversial to this day. Meltzoff claims that a special “like me” learning mechanism underlies infants’ ability to imitate others (Meltzoff & Moore, 1998). Early on in development, individuals understand others as “like me” and therefore the self as like others. Over time, children begin to appreciate the similarities between their own actions and the actions of others (Meltzoff, 2007). Meltzoff claimed that “the recognition of self-other equivalences is the foundation of social cognition” (Meltzoff, 2007, p. 126). This understanding enables imitation in which others’ behaviors are observed and enacted by the child, suggesting a social partnership. This mechanism allows the young infant to begin to acquire a theory of the mind for interpreting others and eventually revise the theory as new information is accumulated (Gopnik & Meltzoff, 1997).

Very young infants, even newborns as young as 7 hours old, can imitate a range of facial gestures including tongue protrusion, mouth opening, and lip-pursing (Meltzoff & Moore, 1983). There are a number of features of these behaviors that suggest that infants intentionally try to match the gesture they produce to the gesture they see. In particular, infants gradually converge on the correct gesture, rather than producing a full fledged imitation at their first attempt. This ability seems based on a domain-specific mechanism that connects information about the external action of another to the internal states of the infant. Furthermore, infants even will make attempts to imitate a gesture they cannot themselves produce such as a large tongue protrusion to one side (Meltzoff & Moore, 1997). Interestingly, there is evidence of distinctive affective reactions when the infant is having difficulty imitating. For example, when babies converge on the correct response they show signs of positive affect such as a brightening of the eyes, whereas when presented with a gesture that they cannot successfully imitate, they show signs of distress (Meltzoff & Moore, 1997).

At around nine months, babies enrich their earlier conception of the mind to include the idea that feelings and actions may be directed at objects. In other words, children discover that mental states include attitudes towards objects. Although newborns simply imitate actions, nine-month-olds will also imitate actions on objects sometimes even after a 24-hour delay with no opportunity to practice the behaviors in between (Meltzoff, 1988). Nine-month-olds can imitate a series of modeled yet novel behaviors such as pushing a set of buttons or shaking plastic eggs filled with pebbles (Meltzoff, 1988). At 14 months of age, infants can delay imitation for up to one week (Meltzoff, 1988). Interestingly, between 14 and 18 months they cannot only defer imitation, but they can generalize it to new settings. For example, children this age who watched a peer model a new behavior in a day care setting imitated that behavior two days later when given a chance to do so in their homes (Hanna & Meltzoff, 1993). By 2 years of age they can reproduce behaviors later even when the materials are changed (Herbert & Hayne, 2000).

Social and Social-Communicative Development

Very young infants respond in distinctive ways to human faces and voices. These are stimuli that they can match to their own internal representation of their own bodies as evidenced by imitative behaviors. From very early on, they seem to prefer these socially bound stimuli and pay more attention to them than to other stimuli. Infants develop certain expectations about persons that contrast with their expectations about physical objects (Trevarthen, 1977). For example, within the first year of life, infants will imitate the actions of persons but not the similar activities of mechanical objects and they become visibly upset when people do not behave actively and contingently or when they maintain a ‘still face’ (Muir & Hains, 1993).

Infants begin to understand that certain stimuli move on their own, whereas others do not (Premack, 1990). This understanding may help infants distinguish between animate beings and inanimate objects. Yet conceiving of persons as animate in the sense of self-moving does not necessarily require a distinctive psychological conception. Premack (1990) has proposed that infants develop a mentalistic framework in which they increasingly appreciate that animate entities act according to goals, desires, and intentions. Similarly, Perner (1991) claimed that a psychological conception of persons further requires an understanding of intentionality. An ordinary intentional act, such as deliberately reaching for an apple, is intentional because it is purposeful and because it manifests internal experiences about or towards some object or event, such as desire (for an apple) or a belief (about apples). Intentional acts, therefore, are very different from merely self-propelled motions; intentional acts are goal-directed, in the service of and directed toward some target or goal and based on experiences of the goal, perception of the surrounding situation, and so on.

Infants themselves intentfully explore objects by six months of age (Piaget, 1952), a skill and interest that is likely promoted in social contexts. Kaye (1982) refers to the infant as an “apprentice” who actively seeks the support from a partner while learning about objects. Caregivers guide infants in their exploration and create experiences that the infant could not have without their support (Vygotsky, 1978).

Early in infancy babies engage in what have been called “conversational dances” (Brazelton & Tronick, 1980). In these interactions babies and adults act in a coordinated way with a burst of gesture and vocalization from the adult matched by a parallel burst from the baby. These interactions are similar to the coordination of gesture and speech in adult conversations. These early social-communicative behaviors may reflect the same sort of underlying link between self and others seen in early imitation. These early “conversations” may give rise to later social and social-communicative skills such as social referencing or joint attention.

There is evidence that infants as young as seven to nine months display signs of intersubjective relatedness. Trevarthan and Hubley (1978, p. 184) define intersubjectivity as “a deliberately sought sharing of experiences about events and things.” Infants learn about the world by monitoring their mothers’ visual perceptions. Beginning around six months of age, infants can follow their mothers’ line of vision when she turns her head (D’Entremont, Hains, & Muir, 1997; Scaife & Bruner, 1975). The gesture of pointing and the act of following another’s line of vision are among the first overt acts that permit inferences about the sharing of attention, or the establishing of joint attention. By nine months of age infants can attend to the target another is referring to as well as refer back to the individual for confirmation that he or she has attended to the appropriate target. Joint attention may be one of the earliest signs of children’s implicit understanding that they can have a particular attentional focus, that another can also have a particular attentional focus, and that these two mental states can be similar or not, and that if they are not, they can be brought into alignment and shared. This is a rather complex understanding of perceptual mental states that emerges early in life. Joint attention ability ultimately enables children to learn from others.

Another aspect of intersubjectivity that enables a child to learn from the social environment is social referencing, the ability to observe another person's emotional response and use this information in one's own reaction. Twelve-month-olds' social referencing ability has been assessed by placing them in situations that are bound to create uncertainty, usually ambivalence between approach and withdrawal. The infant may be lured with an attractive toy to crawl across a "visual cliff" or may be approached by an unusual but highly stimulating object such as a beeping, flashing robot (Rosen, Adamson, & Bakeman, 1992). When the infants encounter these situations and offer signs of uncertainty, they look towards their mothers to read their faces for affective content, essentially to see what they should feel. If the mother has been instructed to show facial pleasure by smiling, the infant often crosses the visual cliff. If the mother has been instructed to show facial fear, the infant turns back from the "cliff," retreats, and may become upset. Similarly, if the mother smiles at the robot, the infant will too. If she shows fear, the infant will become more wary. It seems that infants would not check with their mother in this way unless they attributed to her the capacity to have and to signal an affect that has relevance to their own actual or potential feeling states. When in an ambiguous situation, infants determine their behavior by referring to another's reaction.

Children's social referencing ability becomes increasingly sophisticated as evidenced by Repacholi's study of children's behavior following an even more ambiguous situation. Repacholi (1998) showed 14- and 18-month-olds two closed boxes. The experimenter looked into each box and made a disgusted or happy face, and then gave the closed boxes to the babies. Both groups handled the boxes equally, but both were reluctant to open the disgust box even though they had never seen the emotion in conjunction with the object in the box, just with the outside of the box. Nevertheless, they seemed to infer that the object should be avoided though the outside of the box itself should not be.

At eighteen months of age, babies begin to appreciate how their own intentions and those of others may fail to produce a result and that other people may have different desires than they do. Children at this age begin to imitate others engaging in complex goal-directed behaviors and at about the same time they initiate their own goal-directed behavior. They will also analyze failed attempts to achieve a goal. If they see another person unsuccessfully try to do something, they will themselves produce the correct behavior to reach that goal suggesting a rather sophisticated inferential capacity (Meltzoff, 1995).

In one study, 18-month-olds but not 14-month-olds demonstrated an understanding that their own desires may be different from those of others. If they see another person express disgust towards an object that they themselves like (such as goldfish crackers) and pleasure towards an object that they themselves do not like (such as raw broccoli), they will give that person the broccoli and not the crackers (Repacholi & Gopnik, 1997). Eighteen-month-olds seem able to inhibit their own preference and understand that preferences are tied to the individual. When another offers nonverbal information about their preference, 18-month-olds are able to connect the other person's explicit cues to their own internal mental state, even though it conflicts with their own mental state. This ability to judge one's desires is an important milestone in early understanding of mental states. Although they can attribute different desires to self versus others at this age, they are not yet successful in making such attributions when the mental state is a belief. In general, this milestone is not attained until the fourth year.

Dunn (1988) studied 2-year-olds' interactions with their mothers and siblings. These children engaged in behaviors that would suggest that they are taking an interest in what others know and do not know. Two-year-olds readily offered excuses, deceits, evasions, and tricks as they deemed appropriate. In fact, children as young as 18 months engaged in teasing and comforting of siblings, as though relying on an early appreciation of specific desires, emotions, and beliefs (Dunn, 1988). This behavior also hinges on the ability to contrast the reality of a situation with a differing perception of that reality. Eighteen to 24- month-olds have also been found to talk about what people think, know, and guess, but mere mental state usage is not the same as fully appreciating their own and another's mental states (Astington, 2000). However, when requesting a parent's help in retrieving a toy from a high shelf, 2-year-old children communicated better (i.e., named the toy and gestured to the location) with parents who were not present during the toy's placement than with parents who were present (O'Neill, 1996).

Mental State Understanding during the Preschool Years

Interestingly, "this growing sophistication about the social world, documented in babies who have hardly begun to talk, stands in notable contrast to the limitations in much older children's understanding of other minds, which have been revealed by experimental research" (Dunn, 1991, p. 98). One well-documented limitation during the early preschool years is 3-year-olds' belief that there is one reality, their own, and that others share this reality (Gopnik & Graf, 1988). Another is 3-year-olds' difficulty in recalling the source of their knowledge (Gopnik & Graf, 1988; Perner & Ruffman, 1995;

Povinelli & deBlois, 1992; Taylor et al., 1994; Wimmer, Hogrefe, & Perner, 1988). Most of this literature is categorized as regarding children's developing theory of mind and a variety of experimental tasks have been constructed to assess the changes in mental state understanding during this time. These tasks will be reviewed in this section to describe what is known about preschooler's understanding of mental states, especially their understanding of knowledge.

Theory of Mind

Premack and Woodruff (1978) first used the term "theory of mind" to describe the ability to "…impute mental states to oneself and others. A system of inferences of this kind is properly viewed as a theory, first, because such states are not directly observable, and second, because the system can be used to make predictions, specifically about the behavior of other organisms" (Premack & Woodruff, 1978, p. 515). As primatologists, they uniquely studied whether chimpanzees are able to infer an individual's internal goals based on the individual's observable behavior.

Wellman employed a broader definition of this term, claiming that an understanding that other people have thoughts, feelings, and beliefs separate from one's own reflect a theory of mind (Wellman, 1990). One's theory of mind reflects an understanding that both beliefs and desires determine actions (see Figure 2 for Wellman's model of how this reasoning takes place). Oftentimes we can see the outward signs of what others are experiencing (e.g., sadness, happiness) but our theory of mind enables us to make inferences and assumptions about another's mental states when no such signs are present. For example, we use our theory of mind in order to understand that our friend reached for the cup because he *thought* the cup contained water which he desired because he was *thirsty*. Our theory of mind also enables us to predict with reasonable accuracy what others will think and feel in various circumstances and to explain others' behavior based on mental states.

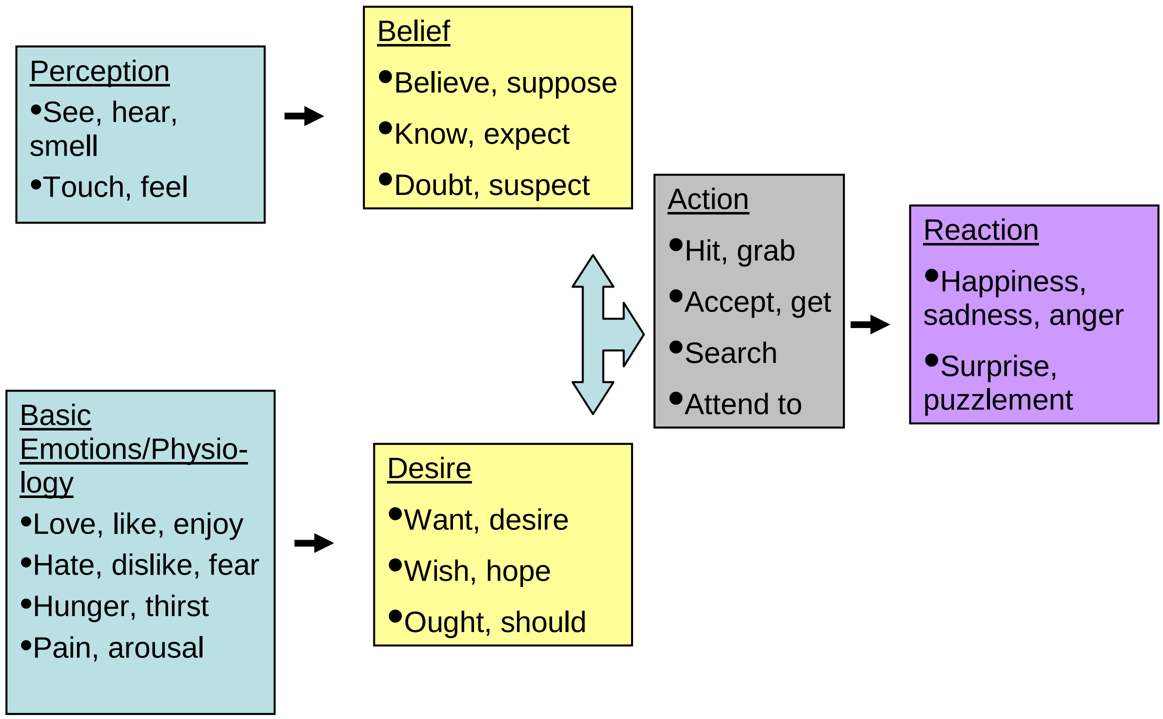


Figure 2. Wellman's Model of Belief-Desire Reasoning (Wellman, 1990).

Theory of mind has traditionally been viewed as the foundation for our adult-like understanding of the social world. Having and more importantly using this social-cognitive ability enables people to attribute independent mental states to predict and explain their own and others' behavior, an ability that would seem vital even early on in life.

The ability to "read" another person's mind is necessary to succeed in any society. The classroom is an ideal symbol of the greater society that children must negotiate. The classroom is comprised of children with differing desires, beliefs, and knowledge. In order for children to successfully relate to and learn from each other, they must appreciate these differences.

Research has found that between 3 and 5 years of age, children increasingly appreciate the subjectivity of mental states in that others may have different beliefs and desires from their own (Baron-Cohen, Leslie, & Frith, 1985; Wellman, 1990; Wimmer & Perner, 1983). By 4 years of age, children begin to build a framework of the causal relationship between these subjective states and actions (Astington & Gopnik, 1991; Wimmer & Hartl, 1991).

Appreciating False Beliefs. Theory of mind research has been examined by assessing a child's ability to discriminate between his or her thoughts and those of another. Given that beliefs are subjectively based on an individual's view of reality, children's theory of mind can be assessed by studying their understanding of how both true and false beliefs are formed. Children's understanding of false beliefs has been of particular interest to study because one's false belief is the result of a discrepancy between the external world and the mental world. It is also important "because it is a gateway to the comprehension of other psychological realities such as the privacy of personal mental experience, the induction of mistaken beliefs in others, and the mind's activity independent of experience (e.g., interpretations, expectations)" (Thompson, 2006, p. 39).

There are several tasks commonly used to assess children's understanding that other people may have false beliefs. One of the first tasks is known as the Location Change task, which was created by Wimmer and Perner (1983) and later modified by Baron-Cohen et al. (1985). In this task a child participant and another child (or puppet) watch as the experimenter places a toy in Location A. The other child (or puppet) then leaves the room, at which time the experimenter moves the toy to Location B. The experimenter then asks the participant where the other child (or puppet) will look for the toy on return. If the participant understands how beliefs are formed, then he or she will indicate that the returning child (or puppet) will believe the toy to be in the original Location A, even though it is really in the new Location B. The participant must understand that his or her belief about the object's location was based on seeing its displacement and others who do not see the displacement will have a false belief about its location. Another task known as the Deceptive Box task developed by Perner, Leekham, & Wimmer (1987) or the Smarties task (Hogrefe, Wimmer, & Perner, 1986) involves unexpected contents of a box. During this task, participants are shown a crayon box, for example, and are then asked what they believe the box contains. Then participants open the box to learn that it actually contains a different substance, such as candies. Lastly, participants are asked what another, who has never looked inside the box, would think is in the box. To pass this task, children must understand that their belief was based on seeing the contents of the box and therefore, others who do not see the contents will have a false belief.

In general, children younger than 4 years old fail false-belief tasks. For example, 3-year-olds fail to identify their prior belief as false in the Deceptive Box task (Hogrefe et al., 1986; Perner et al., 1987). In addition, when asked to predict what another child who was not present during the task would think was in the box, children younger than 4 claim that another child will know the true, unexpected contents. Young preschoolers do not appreciate that knowledge of the true contents was based on direct observation and those without such access will not have the same knowledge. Three-year-olds seem to forget their initial belief when assessed with a traditional false-belief task (Gopnik & Slaughter, 1991). They assert that the current state of the world, or what is more obvious and observable, matches the mental world. They seem unable to fully appreciate the dynamic sophistication of the mental world, such as that beliefs change with additional information.

In general, by 5 years of age, children understand that another person's belief can differ from their own and that the belief can be false (Baron-Cohen et al., 1985; Gopnik & Astington, 1988; Hogrefe et al., 1986; Perner et al., 1987; Wimmer & Hartl, 1991; Wimmer & Perner, 1983). By this age, children understand, as in the case of the Location Change task, that if a character places his prized toy in a specified location prior to departing the room, the character will believe the toy is in this same location and act upon that belief even if the toy was moved during the character's absence.

In addition to young children attributing their own knowledge to others, they also endow others with emotions that are consistent with the attribution of this privileged knowledge. In a study conducted by Harris and colleagues, children were told a story about a monkey who offered a can of Coke to an elephant, the elephant's favorite drink (Harris, Johnson, Hutton, & Andrews, 1989). Unbeknownst to the elephant, but known to the child, the monkey poured the Coke out of the can and replaced it with milk, which the elephant disliked. The child was asked how the elephant felt when she first saw the can, before she sipped any of the liquid inside with her trunk. Both 3- and 4-year-olds judged the elephant's emotion before the elephant discovered the monkey's trick. "They judge that even at this point she will be sad, as if she somehow knew what the monkey had done" (Harris, 1993, p. 238). This study is another illustration of the apparent difficulty young children have in keeping what they know separate from what is known by less informed others.

Several factors seem to affect children's success during these false belief tasks. Language ability is one such factor. Multiple hypotheses exist about the nature of the relationship between language and false belief understanding (Lohmann & Tomasello, 2003). One hypothesis claims that children are interacting with the social environment and that language is one of many variables that facilitates children's developing framework for understanding their own and others' mental states. Some claim that the social discourse ultimately influences false belief understanding (Dunn, 1988; Guajardo & Watson, 2002). In contrast, de Villiers and de Villiers (de Villiers, 2005; de Villiers & de Villiers, 2000; de Villiers & Pyers, 2002) suggest that when adults model appropriate mental state discourse in a particular grammatical form described as syntax of complementation, children's understanding of false beliefs can be enhanced. When parents use mental state terms as subordinate clauses or sentential complements, as indicated in the statement "I thought you took the dog for a walk," the subject's psychological state is highlighted and can positively influence children's understanding of mental states in general.

Children's use of mental state terms has been thought to shed light on their mental state understanding. According to Katherine Nelson (1996), even though young children are using mental states in their lexicon as young as two years of age, children do not discover the true understanding of mental state language until later in development. For example, young children's conversations during pretend play are characterized by a significant number of mental state references (Hughes & Dunn, 1997). Children may use mental state terms during pretend play because during a state of fantasy, they realize that the physical reality does not match their mental reality (Leslie, 1987). However, their use of such terms does not mean that they fully understand mental states.

Understanding Deception. Understanding deception is another capability requiring an appreciation of others' minds. In order for a child to successfully deceive, he or she must first have knowledge that another does not possess. This knowledge then must be concealed from another through deliberate and thoughtful measures. Basically, the child must induce a false belief in another person in order to successfully deceive him or her (Ruffman, Olson, Ash, & Keenan, 1993).

The age at which children first begin to deceive and understand the impact of their deception on another's beliefs is unclear. The findings of some studies indicate that children as young as 2 or 3 might possess these abilities (Chandler, Fritz, & Hala, 1989; Chandler & Hala, 1994; Sullivan & Winner, 1993), whereas other studies suggest that the onset of deceptive capabilities is considerably later, at about 4 or 5 years of age (LaFreniere, 1988; Peskin, 1992; Sodian, 1991).

Perhaps one of the reasons for these age discrepancies is based on methodological differences in how this phenomenon is studied. Successful or not, 2- and 3-year-old children may act "deceptively" towards another by lying (Dunn, 1988) but the level of insight into their behavior is critical in determining whether they fully understand others' beliefs. To successfully deceive another is to behave in a way that induces another to hold a false belief while keeping in mind the true reality of the situation (Ruffman et al., 1993). For example, Peskin (1996) found that 3-year-old children understood that a character in a fictitious story dressed up in order to pretend to be another character, but children at this age did not understand the purpose behind the pretense (to deceive another). In fact, not until 5 years of age can children explain the differences between pretending and lying (Taylor, Lussier, & Maring, 2003).

Source Monitoring. The traditional false-belief tasks in part evaluate children's developing appreciation that visual access is necessary while an object is being displaced to "know" the object's location (Harris, 2006). Without this perceptual access the actor will not truly know the object's location and will therefore act on his false "belief." Therefore, to understand how beliefs are constructed is to understand the belief's source, which may be based on one's perceptions (Wimmer & Hartl, 1991). A developed theory of mind then includes an understanding that appropriate perceptual access results in knowledge formation. Although 3-year-old and young 4-year-old children are successful in considering the knowledge they acquire, they seem fully unaware of the causal relationship between knowledge and its source (Wimmer et al., 1988).

In fact, 3-year-olds can be quite poor at monitoring their perceptual intake of new information (O'Neill & Gopnik, 1991). Gopnik and Graf (1988) showed that between 3- and 5-years of age, children are increasingly able to identify whether the source of their knowledge of an object's identity was based on another's testimony, another's clue, or their own observation.

Some have argued that prior to 4- or 5-years of age, children do not conceive of any connection between perceptual experiences and knowledge (Wimmer, Hogrefe, & Perner, 1988) because they lack an understanding of the causal origins of knowledge (Wimmer, Hogrefe, & Sodian, 1988). In one study, for example, while 95% of 3- and 4-

year-old children correctly identified whether another individual had visual access or not, only 65% of the children correctly identified whether another individual had knowledge or not (Wimmer, Hogrefe, & Perner, 1988). Perner (1991) has proposed that children are more cognitively aware of their own experiences beginning around 4 years of age and therefore better able to encode sensory experiences into their episodic memory. Young preschoolers' memory deficit of the perceptual source of knowledge was also found by O'Neill and her colleagues (O'Neill & Chong, 2001; O'Neill & Gopnik, 1991).

There seem to be significant differences between young 4- and older 5-year-olds' understanding of when knowledge was acquired (Taylor et al., 1994). For example, most 4- and half of 5-year-olds claimed that they had always known newly learned facts about chemistry, and 5-year-olds were significantly more likely to claim that they previously knew a familiar color and not a novel color (e.g., chartreuse, taupe) (Taylor et al.).

Knowledge Acquired from the Senses. Four-year-old children are able to label each of the sensory organs (Cooper, 2007) as well as identify the sensory activity relating to each of the sensory organs (Weinberger & Bushnell, 1994). However, 4-year-olds offer less coherent predictions and explanations of how to acquire sensory-specific knowledge than older children (Weinberger & Bushnell, 1994). Even when a child successfully engages in a sensory-specific investigation of an object such as smelling the liquid contents of two cups in order to detect which contained lemon juice, children do not consistently report the full scope of their sensory investigation such as that they used their nose to find out which liquid smells like lemon (Weinberger & Bushnell, 1994).

Although 4-year-olds have a better understanding of the sensory modalities than 3-year-olds (Cooper, 2007; O'Neill & Chong, 2001; Taylor, 1996), 4-year-olds' understanding is not as sophisticated as what has been previously found in studies of 5-year-olds, who realize that the perceptual access must be modality-appropriate (Norton, 2003; O'Neill et al., 1992; Pillow, 1993). For example, older preschoolers attribute knowledge, such as a hidden object's color or the identity of the contents of a drawer, to those who have appropriate perceptual access (Pillow, 1989; Sodian & Wimmer, 1987). However, children's understanding of the relationship between appropriate perceptual access and knowledge is still tenuous during the latter preschool years. For example, prior to age 5, children may say that a puppet can tell that a ball is blue by feeling it or that a sponge is wet by looking at it (O'Neill et al., 1992). Furthermore, 4- and 5-year-old children have been found to incorrectly attribute knowledge about a drawing to a person who sees only a small uninformative portion of the drawing (Chandler & Helm, 1984; Taylor, 1988).

Children's knowledge about their senses may vary according to the sensory modality in question. For example, 4-year-olds have been found to be quite accurate in identifying seeing as the source of their own or others' beliefs (Gopnik & Graf, 1988; O'Neill & Gopnik, 1991; Weinberger & Bushnell, 1994; Wimmer et al., 1988). Children may, however, overestimate the knowledge acquired through sight (Cooper, 2007; Fabes & Filsinger, 1986; Robinson et al., 1997; Weinberger & Bushnell, 1994). Fabes and Filsinger (1986) observed that in an odor-preference task with both visual and olfactory-based cues, 3- to 5-year-olds based their preferences solely on visual cues until the intensity of the olfactory cues was dramatically increased.

Sometime between three and five years of age, children understand that there are differences in the knowledge that result from using the different sensory organs (O'Neill et al., 1992; Perner & Ruffman, 1995; Pillow, 1993; Wimmer et al., 1988). Pratt and Bryant (1990) assessed young children's ability to discriminate between the knowledge resulting from touching versus seeing. Three-year-olds listened to a story in which one person looked into a box and another person only touched the box. The 3-year-olds were able to infer that the person who looked inside knows the contents of the box and the other person does not. In addition to appreciating that knowledge can be accessed visually, three-year-old children also reliably accept that knowledge can be acquired when another is *told* information, such as the contents of a covered box (Wimmer et al.). In general, when presented with very simple tasks and straightforward questions, 3-year-olds appreciate that there is a relationship between visual access and knowledge of an object.

Knowledge Based on Others' Testimony. Young children understand that knowledge can be acquired when another is told information (Wimmer et al., 1988), but do children evaluate these assertions to determine if the knowledge is accurate? Given preschoolers' difficulty in knowing how knowledge is acquired, they may simply accept others' claims without critically evaluating their accuracy (Thierry, Spence, & Memon, 2001).

There are signs of children evaluating others' claims prior to the preschool years (Baldwin et al., 1996; Koenig & Echols, 2003). Children seem to learn at an early age that communication typically involves the transmission of true beliefs and that there is a link between a speaker's commentary and the referent object. For example, 16-month-old infants appear surprised when a person incorrectly labels an object and will attempt to correct the person (Koenig & Echols, 2003).

Preschoolers are aware that there is variability in people's knowledge (Lutz & Keil, 2002). For example, 4-year-olds appropriately predicted that an adult's knowledge of vocabulary, such as knowledge of the definition of "hypochondriac," would be greater than a child's and that a child, not a baby, would know what a rabbit looks like (Taylor, Cartwright, & Bowden, 1991). Beyond merely inferring adult knowledge as superior to children's knowledge, 4-year-olds also believe a doctor would have more knowledge about biology than would an auto mechanic, but that an auto mechanic would have more knowledge about mechanics than would a doctor (Lutz & Keil, 2002).

Do preschoolers then differentiate their trust of informants based on the perceived variances in informants' knowledge? Three-year-olds routinely learn information from others but more often from confident rather than uncertain individuals (Jaswal & Malone, 2007; Moore et al., 1989; Sabbagh & Baldwin, 2001). For example, 3-year-olds were less likely to learn the labels of novel objects when an adult identified the labels by saying, "maybe this one is a blicket," than when the same adult spoke confidently (Sabbagh & Baldwin, 2001). Children up to 4-years-old were more likely to search for an object in a location recommended by a puppet that expressed greater confidence (e.g., "I *know* it's in the red box") rather than the puppet that seemed less confident (e.g., "I *think* it's in the blue box" or "I *guess* it's in the blue box"; Moore et al.). Both 3- and 4-year-olds were more likely to believe an informant who identified a key-like object as a "spoon" when the informant claimed he made the object than from an informant who merely found the object (Jaswal, 2006). Also, both 3- and 4-year-olds trusted an adult over a child when both demonstrated that they were reliable sources of knowledge (Jaswal & Neely, 2006). In addition, after listening to implausible claims from an informant and watching bystanders' reactions, 3- and 4-year-olds were more likely to believe the claims that were followed by nods versus those followed by frowns from the bystanders (Fusaro & Harris, 2005). Four-year-olds, but not 3-year-olds, learned new words from those who were previously accurate in providing information about the function of known objects (Birch, Luca, Frampton, Vauthier, & Bloom, 2005).

Preschoolers are sensitive to an informant's history in sharing accurate information (Birch et al., 2005; Birch et al., 2008; Clément, Koenig, & Harris, 2004; Jaswal & Neely, 2006; Koenig, Clément, & Harris, 2004). Four-year-olds "learned" the label of an unfamiliar object from a speaker who was previously at least 75% accurate, whereas three-year-olds were more random in whom they "learned" from unless a speaker consistently professed ignorance (Koenig & Harris, 2005).

In addition to considering the trustworthiness of others based on their previous accuracy, children must consider which informant has the most appropriate informational access. Young children have been found to be unable to consider the relationship between informational access and resulting knowledge acquisition (Wimmer et al., 1988). As previously described, young children's difficulty in differentiating among the perceptual channels of information (Gopnik & Graf, 1988) adds to their naiveté of the relationship between knowledge and its source. On the other hand, Whitcombe and Robinson (2000) found that 3-, 4-, and 5-year-olds labeled a partially occluded object based on the testimony offered by the individual with the best informational access.

Metacognition

Perhaps the above literature on preschoolers' understanding about mental states can be included under the auspices of developing metacognitive ability. This highly studied aspect of cognition can be generally defined as thinking about thinking. The term was first coined by John Flavell in 1975. Not long after, the term was more formally defined to refer to “one’s knowledge concerning one’s own cognitive processes and products or anything related to them ... [and] refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes ..., usually in the service of some concrete goal or objective” (Flavell, 1976, p. 232).

During a learning task in which the goal is to acquire new knowledge, a metacognitive awareness of both the strength and the depth of one’s understanding is an important skill. Interestingly, by 4 years of age, children acknowledge differences in meaning when one uses mental state terms. To “know” is based on a different degree of conviction, namely more conviction, than to “think” or to “guess” (Moore et al., 1989; Perner, 1991). These differing levels of certainty were also referenced by Bartsch and Wellman who nicely stated, “a thought that something is so can vary from certain knowledge (know), to a firm belief (believe), to mere speculation (wonder)” (Bartsch & Wellman, 1995, p. 38).

Children’s metacognitive awareness of what they know and what they do not know will affect their success at school (Gopnik et al., 1999). While at school, children “…have to know about knowledge and learn how learning works. [Children] have to know what [they] need to learn and learn how to get new knowledge” (Gopnik, Meltzoff, & Kuhl, 1999, p. 51).

Children’s View of Knowledge

There is evidence of a shift in children’s view of knowledge during the preschool years. Some believe that early in development, “knowledge is seen as absolute and predetermined, and the existence of legitimate alternatives is denied. Such a view of knowledge implies that beliefs do not require justification since one must only observe to know. As a result, knowledge and beliefs are not distinguished; they are simply assumed to exist" (King & Kitchener, 1994, p. 48). Eventually, children begin to appreciate that to "know" is to have a mental representation that is both certain and reflective of a true state of affairs (Montgomery, 1992; Moore & Furrow, 1991; Perner, 1991). In addition, to "know" expresses more speaker certainty than to "think" or "guess" and is a better depiction of the true state of affairs (Montgomery, 1992; Moore & Furrow, 1991; Perner, 1991).

Schommer (Schommer, 1990; Schommer, Crouse, & Rhodes, 1992) has proposed a model of beliefs about knowing and learning. This model includes five dimensions that develop separate from one another (Schommer-Aikins, 2002) and can be assessed in order to begin to explicitly identify the relationship between epistemology and learning. The dimensions include structure, stability, source of knowledge, and control and speed of knowledge acquisition.

Hofer and her colleagues (Burr & Hofer, 2002; Hofer, 2001; Hofer & Pintrich, 1997) have also proposed a multidimensional model but one in which the dimensions are interconnected into larger epistemological theories. These theories include definitions of what knowledge is and how knowledge is acquired (Burr & Hofer, 2002).

Different Explanatory Accounts of the Development of Theory of Mind

Family studies have found clear biological and environmental contributions to children's understanding of mental states. Preschoolers who had at least one sibling between one and twelve years of age outperformed those who did not have siblings or whose siblings were infants or adolescents on a battery of theory of mind tasks (McAlister & Peterson, 2006). In fact, children with at least two older siblings may pass traditional theory of mind tasks as much as one year earlier than average (Perner, 2000). One study assessing the genetic contributions to theory of mind development found substantially higher correlations of task scores between identical (r = .66) as compared to between fraternal twins (r = .33; Hughes & Cutting, 1999).

Current theories of the development of theory of mind differ depending on the extent the social environment is thought to influence the developing theory of mind and depending on whether theory of mind is considered to develop along with or separate from other aspects of cognition. Baron-Cohen (1995) comes from a nativist perspective and suggests that the social environment is not the root of developing social cognitive capabilities but rather maturational changes in the mind are the ultimate mechanism of change. These maturational changes are viewed as domain-specific and include a number of mental modules (Baron-Cohen, 1995; Leslie & Thaiss, 1992). Group differences in this development as can be seen in children with autism are based on a malfunctioning theory of mind module (TOMM).

Alternatively, a more neuropsychological view, namely an executive function account, has also been identified as an explanation of developing theory of mind (Zelazo & Frye, 1996). Children’s developing executive functions have been proposed to serve as a general cognitive mechanism of changes in young children’s ability to understand people mentalistically (Zelazo & Frye, 1996). “Executive functions” refer to the psychological processes involved in the conscious control of thought and action. Based on this theory, differences in working memory and cognitive monitoring ultimately contribute to theory of mind development. Developmental changes in inhibitory control as a construct of executive functioning has a long history of research (Luria, 1966). However, changes in inhibitory control cannot fully explain the changes in mental state understanding because there is evidence of a progressive understanding of mental states in which an understanding of *desires* precedes an understanding of *beliefs,* but both require similar inhibitory control.

Alternatively, the simulation account claims that children infer others' mental states by creating an internal representation of other's behavior and considering their own mental states when they engage in that behavior in similar situations (Gordon, 1986; Harris, 1994). The newly discovered mirror neuron system is evidence of the validity of this account.

The fourth framework is the "theory theory" that claims that children incorporate their knowledge about the mind into an everyday framework (Gopnik & Wellman, 1994). Based on this notion, children are young psychologists who revise their existing theories to account for discrepant experiences. Beginning around 2 years of age, children demonstrate a basic understanding of desires that eventually gives rise to talk about desires, thoughts and beliefs and the ability to explain their own and others' actions based on the actors' desires at around 3 years of age (Bartsch & Wellman, 1995). Finally, by 4 or 5 years of age, children develop a mature understanding of the mind and appreciate that beliefs and desires determine one's actions (Bartsch & Wellman, 1995).

Rationale for this Study

The present study was designed to assess children's understanding of knowledge. Four- and 5-year-old children were given an opportunity to directly acquire modality-specific knowledge about objects. The objects were unique in that only one sensory organ must be employed in order to acquire modality-specific knowledge about each object. Children were also asked how they acquired this knowledge. After observing two same-age peers investigate the same modality-specific objects, children determined whether each peer had correct or incorrect knowledge. One of the peers was correct on each of the five trials and the other peer was incorrect on each of the trials. Children were required to observe and then evaluate the knowledge acquisition procedure of the same peers as they acquired modality-specific knowledge about a different set of objects. During this phase of the task, one of the peers had appropriate perceptual access and therefore acquired accurate modality-specific knowledge whereas the other peer had restricted perceptual access and therefore offered inaccurate modality-specific knowledge. One of the peers was correct on each of the ten trials and the other peer was incorrect on each of the trials. Children were required to consider whether they should trust the peer that was accurate during the first phase of the task or the peer that had appropriate perceptual access during the latter phase of the task. In addition, children's understanding of how they acquired modality-specific knowledge was assessed and differences in their understanding of the modalities were also examined.

I hypothesized that after directly acquiring knowledge, 4- and 5-year-olds would be quite successful in evaluating the accuracy of two same-age peers. During tasks in which the informants label known objects, 3- and 4-year-olds are able to evaluate the accuracy of two adult informants (Birch et al., 2008; Clément et al., 2004; Koenig, et al., 2004; Koenig & Harris, 2005; Pasquini et al., 2007) or a child informant and an adult informant (Jaswal & Neely, 2006).

I also hypothesized that 4-year-olds would subscribe to the testimony of the peer that was previously accurate, regardless of perceptual access. When learning the label of novel objects, 4-year-olds correctly subscribed to the testimony of the previously accurate informant (Birch et al., 2008; Clément et al., 2004; Jaswal & Neely, 2006; Koenig & Harris, 2005; Pasquini et al., 2007). Therefore, by 4 years of age, children use past reliability to guide learning of new information.

Given the importance of acting on accurate knowledge, evaluation of whether another's testimony was acquired appropriately is necessary (Thierry, Spence, & Memon, 2001). When evaluating the efficacy of another's testimony, it is reasonable to assume that children, at least in some circumstances, must also understand the relationship between perceptual access and knowledge. I hypothesized that 5-year-olds would subscribe to the testimony of the peer that had appropriate perceptual access, regardless of previous accuracy. Beginning at 4-years-of-age, children begin to appreciate the causal origins of knowledge (Wimmer et al., 1988). Four- and 5-year-old children's understanding of the relationship between appropriate perceptual access and knowledge is still quite tenuous (Chandler & Helm, 1984; Norton, 2003; O'Neill et al., 1992; Taylor, 1988).

In addition, if an individual is aware of the source of his knowledge, he may be less susceptible to believing others' false assertions. I hypothesized that children's ability to identify how they acquired modality-specific knowledge was related to ability to evaluate others' knowledge acquisition. Three-year-olds often have difficulty in identifying the source of their knowledge (Gopnik & Graf, 1988; Perner & Ruffman, 1995; Povinelli & deBlois, 1992; Taylor et al., 1994; Whitcombe & Robinson, 2000;

Wimmer et al., 1988). It has been found that "children's source monitoring abilities seem to undergo a dramatic shift between the ages of 4 and 6 years" (Drummey & Newcombe, 2002, p. 509).

Children's understanding of modality-specific knowledge may be based on their understanding of each of the senses. I predicted that children would be more successful in evaluating the accuracy of visual-specific knowledge than auditory-specific tactile-specific, tactile-specific, olfactory-specific, and gustatory-specific knowledge. Four-year-olds have been found to be more successful in understanding the source of visual-specific knowledge than other modality-specific sources of knowledge (Gopnik & Graf, 1988; Norton, 2003; O'Neill & Gopnik, 1991; Weinberger & Bushnell, 1994; Wimmer et al., 1988).

Children have been found to overestimate the knowledge acquired through sight (Cooper, 2007; Fabes & Filsinger, 1986; Robinson et al., 1997; Weinberger & Bushnell, 1994). Therefore, I predicted that children would overestimate the power of another's sight when attempting to acquire non-visual-specific knowledge. In turn, children would falsely attribute knowledge to another when the other person has irrelevant visual access.

These developmental changes during the preschool years affect children's understanding of knowledge. No one has investigated children's evaluations of others' knowledge based on their understanding of where knowledge comes from; therefore it is not fully clear whether 4- and 5-year-old children would subscribe to the testimony of a previously reliable informant or subscribe to the testimony of an informant who has appropriate perceptual access to acquire modality-specific knowledge. This study assessed 4- and 5-year-old children's understanding of knowledge by assessing: their evaluations of others' knowledge, their ability to identify the source of their own knowledge, and their understanding of the relationship between perceptual access and knowledge.

CHAPTER III

METHODOLOGY

Research Design

This study employed a cross-sectional, experimental design. The relationship between age and understanding of knowledge was assessed after asking participants to choose whether they trust the knowledge of a peer who does not have appropriate perceptual access but who was previously a reliable source or if they trust the knowledge of a peer who has appropriate perceptual access but who was previously an unreliable source of knowledge.

In addition to examining age differences in children's understanding of knowledge, I also assessed children's understanding of distinctions among the sensory modalities (e.g., visual-specific, auditory-specific, olfactory-specific, gustatory-specific, and tactile-specific knowledge). Lastly, age differences in children's overestimation of the importance of particular sensory organs were assessed.

Participants

One-hundred and seventy-six children between the ages of 48 and 72 months participated in this study. The mean age was 58.89 months (SD = 6.71). Ninety-one of the participants were boys and eighty-five were girls. The mean age of the boys was 59.31 months (SD = 7.08). The mean age of the girls was 58.44 months (SD = 6.31).

Participants were recruited from 13 preschools from 3 different communities in Colorado and Texas. All preschools were private. Many were affiliated with an area church and none employed a Montessori curriculum. Some of the preschools offered only a half-day program and the rest had both half-day or full day programs. All preschool programs adopted similar philosophies (see Appendix J for descriptions of some of the preschool programs). Generally, preschool staff endeavored to meet the full spectrum of children's needs in a warm and affectionate and often Christian manner.

A parent flyer, informed consent form, parent questionnaire, and envelope were distributed to all children at each site who were at least 14 days from their fourth birthday and no more than 14 days after their sixth birthday (see Appendix F, G, & H). Parents were asked to read the informed consent form, complete the parent questionnaire, and enclose all completed documents in an attached envelope to ensure confidentiality.

Parents of participants completed a short questionnaire about their child (see Appendix H). The primary language for all participants was English except for two participants (English/Portuguese and Vietnamese). Ten of the participants had a medical condition: three 5-year-old children with asthma, one 5-year-old child with a tree nut allergy, one 5-year-old with sidus inversus, one 5-year-old child with chronic lung disease, one 4-year-old child had a repaired heart defect, one 5-year-old with cystic fibrosis, one 4-year-old child with mild cerebral palsy affecting gait and spasticity in legs, and one 4-year-old child had a brain aneurism at 21 months of age. Five of the participants had a learning or developmental disability: one 5-year-old child with a speech delay, one 4-year-old child with a speech impediment, one 5-year-old child with a speech impediment, one 5-year-old child with Central Auditory Processing Disorder, and one 5-year-old child with Sensory Processing Disorder. These participants seemed to perform typically on the task and their native language differences, medical conditions, or developmental or learning conditions did not seem to affect performance. Therefore, all participants were included in this study.

There was great variability in the length of time participants were in a preschool program. Participants' age of entry ranged from 3 months to 69 months. The mean age of entry was 40.34 months (*SD* = 11.46). The length of time in which children had been participating in a preschool program ranged from less than 1 month to 55 months. The mean length of time was 18.57 months (*SD* = 12.80).

Participants were randomly assigned to one of four conditions. The four conditions are referred to as Condition 1 (Model A accurate & access), Condition 2 (Model A accurate & no access), Condition 3 (Model B accurate & access), and Condition 4 (Model B accurate & no access; see Table 1 for the experimental condition matrix). The four conditions were designed so that the models' accuracy could be systematically manipulated during the Model Competency Evaluation phase and the Testing phase. During the Model Competency Evaluation phase one model thoroughly investigated the contents of the objects and therefore acquired and offered accurate modality-specific knowledge, whereas the other model only looked at the outside of the objects and therefore offered a reasonable guess when asked about the objects' contents. During the Testing phase one model had appropriate perceptual access in order to investigate the modality-specific contents of objects whereas the other model wore a sensory inhibitor that blocked his ability to investigate the modality-specific contents in question. Therefore, the model with appropriate perceptual access acquired and offered accurate modality-specific knowledge in contrast to the other model without perceptual access who did not acquire accurate knowledge and therefore offered a reasonable guess based on the question. Participants were randomly assigned to one of the four conditions until 40 participants of the same gender and in the same age group were tested. These data were tracked in a table (see Appendix I for the participant distribution list).

Table 1

Experimental Conditions Matrix

		Task	
Condition Type		Model Competency Evaluation Phase	Testing Phase
1	Model A Reliable & access	Model A = accurate Model B = inaccurate	Model A = access Model B = no access
2	Model A Reliable & no access	Model A = accurate Model B = inaccurate	Model A = no access Model B = access
3	Model B Reliable & access	Model A = inaccurate Model B = accurate	Model A = no access Model B = access
4	Model B Reliable & no access	Model A = inaccurate Model B = accurate	Model A = access Model B = no access

Participants were also randomly assigned to one of three question order conditions. Modality trials were ordered differently in order to minimize any differences in performance based on asking about a more challenging modality first versus an easier modality first (see Table 2 for the question order matrix). Based on previous research, children's understanding of olfaction is the most challenging modality (Cooper, 2007; Norton, 2003). Therefore, olfaction was not assessed until the third or fifth trial depending on the question order assigned to the participant. Questions were ordered in three different ways (referred to this point forward as A, B, or C).

Table 2

Question Order Matrix

		Question Order		
Task		A	B	C
Model	1st Trial	Vision	Tactile	Audition
Competency	2nd Trial	Audition	Gustatory	Gustatory
Evaluation	3rd Trial	Tactile	Olfactory	Olfactory
Phase	4th Trial	Gustatory	Vision	Vision
	5th Trial	Olfactory	Audition	Tactile
Testing	1st Trial	Vision	Tactile	Audition
Phase	2nd Trial	Audition	Gustatory	Gustatory
	3rd Trial	Tactile	Olfactory	Olfactory
	4th Trial	Gustatory	Vision	Vision
	5th Trial	Olfactory	Audition	Tactile

Instrumentation

Children's knowledge of how modality-specific knowledge is acquired was assessed during the Model Competency Evaluation Phase and the Testing Phase. The questioning method adopted during the Model Competency Evaluation Phase was influenced by previous research on children's trustworthiness (see Birch et al., 2008; Clément et al., 2004; Harris, 2007; Jaswal & Neely, 2006; Koenig & Harris, 2005; Pasquini et al., 2007). The stimuli used in the Testing Phase were influenced by the work of O'Neill and her colleagues (see O'Neill & Chong, 2001). Modified versions of the testing phase were used in two previous studies (Cooper, 2007; Norton, 2003).

Model Competency Evaluation

The materials used during the Model Competency Evaluation included a container with modality-specific contents for each of the five modalities (see Figure 3). A viewfinder containing a Thomas the Train view card was used to assess the visual modality. A portable compact disc player with attached headphones with a children's Mickey Mouse compact disc was used for the auditory stimuli. An opaque quilted bag containing a spoon was used for the tactile stimuli. An opaque mug with a cover containing apple juice was used for the gustatory stimuli. An opaque bottle containing lemon bubble bath was used for the olfactory stimuli.

Figure 3. Modality-Specific Stimuli Used During the Model Competency Phase.

Testing Phase

The testing phase included the use of sensory-specific stimuli and sensory inhibitors. The sensory-specific stimuli included two different stimuli for each of the sensory modalities, totaling ten different materials (see Figure 4). A yellow ball in an opaque plastic container and a spotted plastic cheetah in an opaque bag were used to assess the visual modality. A small children's musical toy and a small radio were used for the audition modality trials. A porcelain piggy bank and a plastic bowl filled with water were used for the tactile trials. A child size plastic cup filled with water and a red lollipop were used in the gustatory trials. A spray bottle containing vanilla extract and a red candle were used in the olfactory trials.

Figure 4. Modality-Specific Stimuli Used During the Testing Phase.

The sensory inhibitors included an eye mask, ear muffs, a pair of oven mitts, a doctor's mouth mask, and a swimmer's nose pincher (see Figure 5). When worn, each of the sensory inhibitors blocks one sensory organ and therefore interferes with using that sensory organ to perceive information (e.g., the eye mask covers the eyes which lead to no visual perception of an object).

Figure 5. Sensory Inhibitors Used During the Testing Phase.

Procedure

Each of the four conditions included a model competency evaluation phase followed by a testing phase. All participants were invited one at a time to play a "preschool game" with the experimenter in a quiet area of their school. Participants sat next to the experimenter at a table. A laptop computer was set up on the table along with the stimuli to be used in the model competency evaluation phase.

Model Competency Evaluation Phase

The Model Competency Evaluation phase allowed the participants to directly acquire modality-specific knowledge and then witness how two peers acquire accurate or inaccurate modality-specific knowledge. By first directly acquiring knowledge, and then observing and comparing how and what knowledge was acquired by the models, the participant was then able to assess which of the peers was a reliable source of knowledge.

The Model Competency Evaluation phase began when the experimenter showed two laminated photographs of two children who “go to a different preschool” and who “previously played this game.” The 7” x 5” photographs showed each model’s head, neck and trunk. The participants were told, “Look how this boy is wearing a green shirt and this one is wearing a yellow shirt” (referred to here as Model A and Model B, respectively).

Following this short introduction, participants were referred to the first modality-specific content stimulus (see Appendix B). Participants were asked to identify the modality-specific contents. After each participant identified the contents, the experimenter then presented 3.5” x 5” photographs of each of the five sensory organs and placed each photograph in a row on the table in front of the child. Then the participant was asked *how* he or she discovered the modality-specific contents. Participants either pointed to one of the photographs, pointed to the sensory organ on their body that they used, or verbally indicated what sensory organ was used (e.g., “I used my nose.”). The experimenter then removed the photographs. Next the participant was instructed to look at the computer screen to witness the two models' knowledge-seeking behavior and to hear each of the models' answers to the same question about the same stimulus (e.g., "Remember the two boys? These are kids like you that have never seen these things before. Now watch how they played the game."). After each model identified the modality-specific contents for the given stimulus, the experimenter repeated the label stated by the model and then asked the participant whether the model was right or wrong. This sequence continued so that the participant was asked one at a time to identify the modality-specific contents of five different objects (i.e., the scene in a viewfinder, the song on a compact disc player, the label of a texture-specific object, the type of beverage, and the scent of a liquid), then the participant was asked how he acquired this knowledge, then the participant observed as each model investigated the modality-specific contents and offered divergent testimony, and lastly the participant evaluated each model's knowledge.

In order to increase participants' attention to the tasks, they were offered treats (e.g., M&Ms™, Skittle™, Froot Loops™) randomly throughout the task for "doing a good job." I expected that the participants would easily identify the correct modality-specific contents for each of the five stimuli. For each condition, one peer model shared accurate knowledge about the objects by using the appropriate sensory organ related to the question at hand, and the other shared inaccurate knowledge about the objects by simply looking at the container and not properly investigating the contents for each trial. The participants were told that the models were also offered treats for "doing a good job" so that the "game" experience was similar. This was important so that the participant understood that the models were also motivated to be accurate.

Participants' responses were coded as 0 for all incorrect responses and 1 for all correct responses. Participants were asked to identify the modality-specific contents (possible range=0-5), identify how they learned the contents (possible range=0-5), and indicate whether each of the two models' responses was correct or incorrect for each of the five modalities (possible range=0-5 for each model). Each participant's Model Competency Evaluation Phase score was calculated based on whether he or she accurately evaluated the models' knowledge (possible range=0-10; see Appendix B for the Model Competency Evaluation Phase score sheet).

Conservative and liberal scoring procedures were adopted when coding participants' identifications of the modality-specific contents for the gustatory and olfactory trials (e.g., drink contents of opaque mug and scent of bubble bath). Based on the conservative scoring procedure for the gustatory trial, only those that identified the contents as "apple juice" were coded as 1 or correct and all other responses were coded as 0 or incorrect. Whereas the liberal scoring procedure for the gustatory trial, resulted in coding any response referencing a taste or a flavor as 1 or correct and all other responses were coded as 0 or incorrect. Based on the liberal scheme, responses such as Coke, grape juice, iced tea, and Gatorade were coded as correct responses for the gustatory trial. Based on the conservative scoring procedure for the olfactory trial, only those that identified the contents as "lemon" were coded as 1 or correct and all other responses were coded as 0 or incorrect. In contrast, the liberal scoring procedure for the olfactory trial resulted in coding any response referencing a smell or a scent as 1 or correct and all other responses were coded as 0 or incorrect. For example, responses such as strawberry, blueberry, sour, and coconut were coded as correct responses for the olfactory trial based on the liberal scheme.

Sensory Inhibitor Phase

Following the Model Competency Evaluation Phase, the experimenter demonstrated the function of each of the five sensory inhibitors. The experimenter explained how during this part of the game she played tricks on the two models by having them wear one of the sensory inhibitors. The participant watched as the experimenter identified where the sensory inhibitor is worn (e.g., “This goes on my eyes, just like this”), put on the item, and highlighted how the wearable item interferes with a sensory organ (e.g., “Oh no, I can’t see. Where are you?”). This sequence continued so that each of the sensory inhibitors was shown or worn, and its function described. Last, the participants were given an opportunity to try on any of the sensory inhibitors.

Testing Phase

Following the Model Competency Evaluation phase, participants observed the same two actors engage in modality-specific knowledge acquisition with a set of 10 different stimuli. Unlike the model competency evaluation phase, participants were not given the opportunity to directly acquire this knowledge. Participants were therefore required to acquire such knowledge indirectly from one of the models by evaluating which model can be most trusted based on the model’s previous reliability and/or knowledge seeking behavior during the Testing phase.

The experimenter reminded the participants of the two models from the game by placing the photograph of each model in a row in front of the computer. Participants watched the computer screen as one of the models was introduced to a modality-specific stimulus (e.g., “There’s a ball in that bucket.”) and asked about a modality-specific characteristic of the stimuli (e.g., “What color is the ball?”). Next the participants watched as the experimenter adorned the model with one of the sensory inhibitors (e.g., for the vision trials, the inaccurate model wore the eye mask and the accurate model wore the ear muffs). The participant then watched as the model attempted to acquire modality-specific knowledge about the stimulus and ultimately shared his finding. This sequence then occurred with the second model using the same stimulus but a different sensory inhibitor. After the second model shared his finding, the experimenter placed the sensory inhibitor that each model wore on each photograph and reminded the participant of the model’s finding and the sensory inhibitor he wore. Depending on the condition, either Model A or Model B had appropriate perceptual access whereas the other was without such access. After each model offered his divergent findings, participants were asked to repeat what each model thought, “So what does he think it is?” to ensure attention and memory. After both models investigated the stimulus and shared their findings, and the experimenter repeated the models’ findings, the participant was asked which model was correct. The experimenter presented the two photographs of the models so that the participant could simply point to the model that he believed was correct (see Appendix C for the Testing Phase score sheet).

Participants needed to consider whether they should trust the model that was reliable during the Model Competency Evaluation phase and/or the model that had appropriate perceptual access during the Testing phase. In two conditions, the model that was previously reliable did not have appropriate perceptual access; therefore, the model should not be trusted. In these conditions, regardless of previous knowledge acquisition behavior, there was no way the model could have acquired accurate knowledge. Whereas in two other conditions, the previously unreliable informant who was deemed not trustworthy now had appropriate perceptual access and therefore could be trusted if and only if the participant believed that based on appropriate perceptual access the model's knowledge was accurate.

Participants' responses were coded as 0 for all incorrect responses and 1 for all correct responses. Participants were asked to respond to each of the two modality-specific knowledge questions for each of the five modalities based on their observations of the models' knowledge seeking behavior (possible range=0-10). Modality-specific composite scores were calculated by adding the scores for each of the two trials for each of the five modalities (possible range=0-2 for each of the modalities; see Appendix C for the Testing Phase score sheet).

Pilot Study

A total of 16 children participated in the pilot study. There were 5 boys and 11 girls. The average age was 62.13 months and the age range was 49 to 70 months. Participants were intentionally chosen so the 4-year-old group was comprised of children between 4 and 4 years, 6 months and the 5-year-old group was comprised of children between 5 years, six months and 6 years.

Table 3 shows the overall means, standard deviations, and range for the subscores and total scores for each of the two tasks. The table also shows the means and standard deviations for the 4-year-old participants and the 5-year-old participants in Condition 4 and the 5-year-old participants in Condition 3. In terms of age differences, 5-year-olds outperformed 4-year-olds especially in the Testing phase. In terms of differences between the two conditions, the 5-year-olds in Condition 3 outperformed the 5-year-olds in Condition 4. Recall that Condition 4 requires participants to trust the model in the Testing phase that was previously incorrect during the Model Competency Evaluation phase whereas in Condition 3, the model that was correct during the Model Competency Evaluation phase was also correct during the Testing phase. Therefore, given the difficulty in monitoring which model to trust, the Testing phase scores in Condition 4 would likely be lower than the Testing phase scores in Condition 3.

Table 3

Means, Standard Deviations, and Range of Scores and Subscores by Task, Age Group, and Condition in the Pilot Study

Task *Subscores*	Overall			Condition 4 Age 4 Group (n = 4)		Condition 4 Age 5 Group (n = 5)		Condition 3 Age 5 Group (n = 7)	
	M	SD	Range	*M*	SD	*M*	SD	*M*	SD
Model Competency Evaluation Total	9.19	1.05	6-10	8.75	0.50	8.60	1.52	9.86	0.38
Participant Identification of Object	3.81	0.40	3-4	3.50	0.58	4.00	0.00	3.86	0.38
Participant Explanation of How	4.13	1.03	1-5	4.25	0.50	3.80	0.45	4.29	1.50
Testing Total	6.81	3.54	0-10	4.00	3.46	6.00	4.06	9.00	1.73
Vision	0.88	0.81		0.50	0.58	1.00	1.00	1.00	0.82
Audition	0.94	0.77		0.75	0.96	1.00	0.71	1.00	0.82
Tactile	1.06	0.93		1.25	0.96	1.40	0.89	0.71	0.95
Taste	1.00	0.97		0.75	0.96	1.20	1.10	1.00	1.00
Olfaction	1.00	0.89		0.75	0.96	1.40	0.89	0.86	0.90

Data Analysis

What are the differences between 4- and 5-year-olds' understanding of knowledge about physical objects?

The differences between 4- and 5-year-olds' understanding of knowledge were assessed during the Model Competency Evaluation phase and Testing phase. The means, standard deviations, and ranges were calculated for both the older and younger children for both phases of the task. I predicted that there would be no significant differences between 4- and 5-year-olds' total score on the Model Competency phase (possible range=0-10). I also predicted that 5-year-olds' total score on the Testing phase (possible range=0-10) would be significantly higher than that of the 4-year-olds especially during conditions (i.e., Condition 2 and Condition 4) in which the model that was accurate during the Model Competency Evaluation phase was inaccurate during the Testing phase. Last, I predicted that there would be no significant differences between boys and girls on either of the total scores. Therefore, a 2 x 2 x 4 (age x gender x condition) MANOVA was conducted to assess for differences on each of the two phase scores. The independent variables were age (4- and 5-year-olds), gender (boys and girls), and Condition (informant was reliable or unreliable during the Model Competency Evaluation phase and informant had perceptual access or informant did not have perceptual access during the Testing phase resulting in Conditions 1, 2, 3, or 4). The dependent variables were the Model Competency Evaluation phase score and Testing phase score. A main effect of age on testing phase score was predicted. An interaction between age and condition on the testing phase score was also predicted.

Table 4

Means and Standard Deviations for the Total Model Competency Evaluation Phase Score and Total Testing Score for Groups Based on Age, Gender, and Condition

			Age 4 Group				Age 5 Group			
			Condition				Condition			
	Gender		1	2	3	4	1	2	3	4
Model	Boys	*M*	8.63	8.91	8.92	8.64	7.54	8.57	9.08	9.00
Comp.		SD	1.60	1.04	0.86	1.12	1.56	0.65	1.00	0.87
Evaluation	Girls	*M*	8.36	6.82	8.42	7.55	9.30	8.60	8.56	8.73
Scores		SD	1.80	1.83	1.17	2.12	0.82	0.70	1.67	0.47
Testing	Boys	*M*	7.13	4.91	6.08	4.91	8.46	5.79	8.67	6.89
Scores		SD	3.64	3.83	2.99	3.27	2.07	3.73	1.44	3.30
	Girls	*M*	7.64	3.91	6.33	5.36	9.30	8.60	9.22	7.82
		SD	3.04	2.55	3.06	3.47	1.57	1.78	1.64	2.96

What knowledge is related to children’s understanding of knowledge about physical objects?

Total score on the five (i.e., one question for each modality) “how did you know that?” questions during the Model Competency Evaluation phase (possible range=0-5) and total score on the Testing Phase (possible range=0-10) were calculated for each participant. A significant positive relationship between the two scores was predicted. In order to test this hypothesis, correlations between total score on the “how did you know that?” questions and total score on the Testing Phase were calculated.

Are there differences in children’s understanding of how knowledge about physical objects is acquired based on the modality?

Total scores on the visual-specific, auditory-specific, tactile-specific, olfactory-specific, and gustatory-specific trials during the Testing Phase (possible range=0-2 for each modality) were calculated for each participant. I predicted that 4-year-old children would overestimate the power of another’s sight when attempting to acquire non-visual specific knowledge. In order to test this hypothesis, a 2 x 5 (age x modality scores) ANOVA was computed to assess for significant age differences on each of the five modality-specific knowledge scores from the testing phase. The independent variable was age, and the dependent variables were the five modality-specific knowledge scores. A significant effect of age was predicted for each of the modality scores.

CHAPTER IV

RESULTS

This chapter includes the descriptive data results, the results of the statistical analyses for each of the research questions, and the results of the secondary analyses of data gathered.

Descriptive Results

The descriptive results section includes information about the gender and age composition of participants in each condition. This section also includes the means, standard deviations, and range of total scores for the Model Evaluation Competency and the Testing phase based on condition, gender, and age.

In order to assess for developmental differences, the participants were divided into two age groups: 4.0 to 4.11 years (M = 53.25, SD = 3.53, n = 88) and 5.0 to 6.0 years (M = 64.52, SD = 3.73, n = 88). The 4-year-old group included 43 boys and 45 girls. The 5-year-old group included 48 boys and 40 girls.

Table 5 shows the age, gender, and question order distribution for each of the four conditions. The number in each cell reflects the number of participants. This table highlights the range in the number of participants in each condition. As a result of the randomization procedure I adopted in order to assign participants to each condition (see the participant section of Chapter 3), there were one to nine participants in each condition.

Table 5

Number of Participants by Age, Gender, Question Order, and Condition

	Age 4 Group												Age 5 Group											
	Condition												Condition											
	1			2			3			4			1			2			3			4		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Boys	3	4	1	5	3	3	4	4	5	2	2	7	4	4	5	2	3	9	5	4	3	4	2	3
Girls	4	3	4	3	7	1	3	5	4	5	4	2	3	3	4	5	4	1	2	3	4	3	6	2

In order to assess whether the question order had an effect on performance, I conducted a one-way ANOVA. Based on mean scores on the Model Competency Evaluation phase, participants in the Question Order A Condition (M = 8.77, SD = 1.32, n = 57) outperformed participants in the Question Order B Condition (M = 8.15, SD = 1.47, n = 61) and Question Order C Condition (M = 8.48, SD = 1.29, n = 58). Based on mean scores on the Testing phase, participants in the Question Order A Condition (M = 7.37, SD = 3.24, n = 57) outperformed participants in the Question Order B Condition (M = 6.67, SD = 3.12, n = 61) and the Question Order C Condition (M = 6.62, SD = 3.26, n = 58). Therefore, participants in the Question Order A Condition were the most successful during each phase. Question Order A began by assessing participants' understanding of vision, the most understood modality. By starting with the most understood modality first, participants may begin the task by dedicating some of their cognitive resources toward thinking more deeply about knowledge acquisition. Regardless, based on the results of the ANOVA, question order did not significantly effect Model Competency Evaluation scores ($F(2, 173) = 3.10$, $p = 0.05$) or Test Total scores ($F(2, 173) = 0.98$, $p = 0.38$). Therefore question order was collapsed as a variable in order to better understand developmental differences in each condition.

Table 6 shows the number and percentage of boys and girls in each age group that were in each of the four conditions. I attempted to create an equal distribution of boys and girls in each age group and an equal distribution of boys and girls in each condition. Participants in each condition were no more than 58% of one gender for each age group.

Table 6

Number and Percentage of Participants in each Condition by Age and Gender

	Age 4 Group								Age 5 Group							
	Condition								Condition							
	1		2		3		4		1		2		3		4	
Gender	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Boys	8	42	11	50	13	52	11	50	13	57	14	58	12	57	9	45
Girls	11	58	11	50	12	48	11	50	10	43	10	42	9	43	11	55
Total *n*	19		22		25		22		23		24		21		20	

In order to further evaluate participants' performances on the Model Competency Evaluation phase and the Testing phase, the distribution of the two total scores was assessed. For both the Model Competency Evaluation scores and the total Testing phase scores, the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality were highly significant, indicating that both distributions were not normal. Total scores on the Model Competency Evaluation phase were positively skewed; 99% of the participants scored 5 or higher. Thirty-seven participants (nineteen 4-year-olds and eighteen 5-year-olds) earned perfect scores on the Model Competency Evaluation phase. There was a rather steep distribution of the Model Competency Evaluation scores based on the kurtosis score and review of the histogram. The Testing phase scores were slightly positively skewed; 77% of the participants scored 5 or higher. Fifty-five participants (twenty-one 4-year-olds and thirty-four 5-year-olds) earned perfect scores on the Testing phase. The Testing phase score distribution was more flat than the Model Competency Evaluation scores.

Table 7 shows the means, standard deviations, and the range of the total scores for the Model Competency Evaluation phase and the Testing phase. Consistent with expectations, the two age groups scored similarly well and did not have significantly different performances during the Model Competency Evaluation phase and the older group significantly outperformed the younger group during the Testing phase.

Table 7

Means, Standard Deviations, and Range of Scores by Phase and Age Group

Phase	Overall			Age 4 Group (n = 88)			Age 5 Group (n = 88)		
	M	SD	Range	*M*	SD	Range	*M*	SD	Range
Model Competency Evaluation	8.46	1.38	4-10	8.28	1.58	4-10	8.64	1.13	5-10
Testing	6.88	3.20	0-10	5.75	3.30	0-10	8.01	2.68	0-10

In order to further analyze performance during the Model Competency Evaluation phase, I examined the means, standard deviations, and range of scores based on age, gender, and condition (see Table 8). During this phase, participants should perform similarly regardless of age, gender, and condition. All groups were at least 80% successful, except for two groups comprised of 4-year-old girls (i.e., 68.2% and 75.5% successful) and one 5-year-old boy group (i.e., 75.4% successful). It is not clear why these 3 groups underperformed. The results for tests of statistically significant differences are included later in this chapter.

Table 8

Means, Standard Deviations, and Range of Model Competency Evaluation Scores by Age Group, Gender, and Condition

		Age 4 Group				Age 5 Group			
		Condition				Condition			
Gender		1	2	3	4	1	2	3	4
Boys	*M*	8.63	8.91	8.92	8.64	7.54	8.57	9.08	9.00
	SD	1.60	1.04	0.86	1.12	1.56	0.65	1.00	0.87
	Range	5-10	7-10	8-10	6-10	5-10	8-10	7-10	8-10
Girls	*M*	8.36	6.82	8.42	7.55	9.30	8.60	8.56	8.73
	SD	1.80	1.83	1.17	2.12	0.82	0.70	1.67	0.47
	Range	5-10	4-9	7-10	5-10	8-10	7-9	5-10	8-9

In order to further analyze overall performance during the Testing phase, I examined the means, standard deviations, and range of scores as a function of age, gender, and condition (see Table 9). Average Testing phase scores for the 4-year-olds ranged from 3.91 to 7.64, depending on gender and condition, whereas average Testing phase scores for the 5-year-olds ranged from 5.79 to 9.30, depending on gender and condition. Consistent with expectations, participants in Conditions 1 and 3 outperformed their same-age counterparts in Conditions 2 and 4.

Table 9

Means, Standard Deviations, and Range of Testing Phase Scores by Age Group, Gender, and Condition

		Age 4 Group				Age 5 Group			
		Condition				Condition			
Gender		1	2	3	4	1	2	3	4
Boys	*M*	7.13	4.91	6.08	4.91	8.46	5.79	8.67	6.89
	SD	3.64	3.83	2.99	3.27	2.07	3.73	1.44	3.30
	Range	0-10	0-10	1-10	0-10	2-10	0-10	6-10	0-10
Girls	*M*	7.64	3.91	6.33	5.36	9.30	8.60	9.22	7.82
	SD	3.04	2.55	3.06	3.47	1.57	1.78	1.64	2.96
	Range	1-10	0-7	2-10	0-10	5-10	5-10	5-10	0-10

Participants' Evaluations of the Models

Model Competency Evaluation Phase

The Model Competency Evaluation phase was designed to assess children's ability to directly acquire modality-specific knowledge, identify how they acquired the knowledge, and then evaluate the accuracy of two models after each attempted to acquire the same modality-specific knowledge. As predicted, both 4- and 5-year-olds were quite successful in evaluating the knowledge of others. Many 4- and 5-year-old children seemed to explicitly track whether a model was trustworthy or not. For example, one participant predicted, “he’s going to be wrong again” after the third trial and many participants commented, “he’s always wrong.” Another said, “he’s not smarter” when referencing the incorrect model and “he’s always right” when referencing the correct model. Other participants shared “that kid in the yellow shirt is always wrong,” “he’s right just like me,” “maybe the yellow boy will know,” and “he’s the right kid and the kid in the green shirt is the wrong kid” during the Model Competency Evaluation phase.

In order to assess whether there were differences in participants’ evaluations of the model’s knowledge based on idiosyncratic differences between the models, evaluation scores for each model were compiled and are included in Figure 6. Participants did not appear to evaluate one of the models more harshly or easier than the other although children were slightly less successful in evaluating Model A, the first model, than Model B for all trials except the gustatory trials.

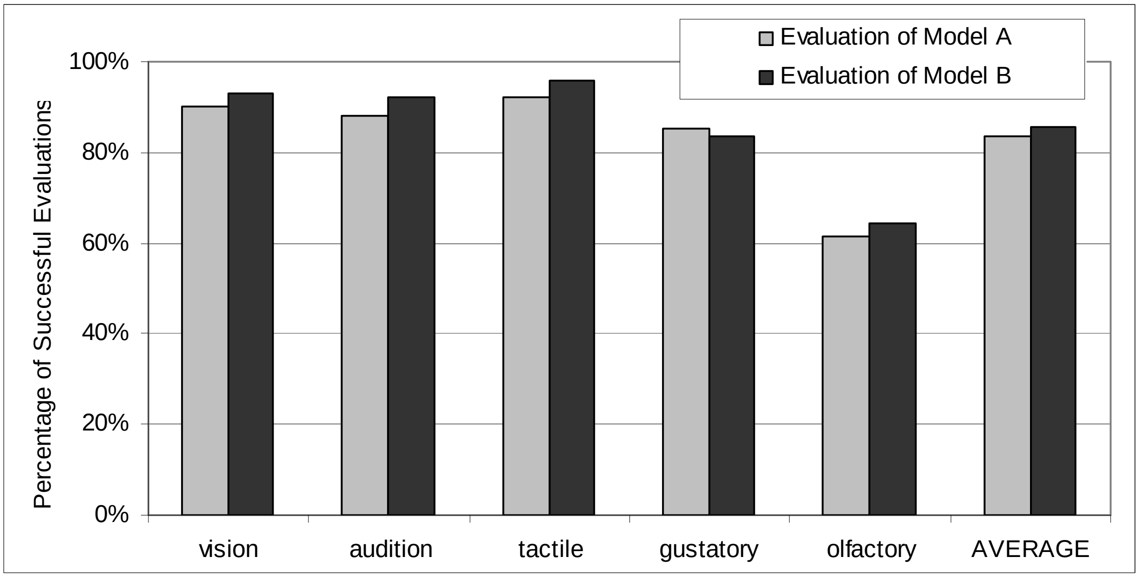


Figure 6. Evaluations of Model A and Model B for Each Trial During Model Competency Evaluation Phase

Testing Phase

In order to assess whether children evaluated the models based on idiosyncratic differences during the Testing phase, evaluation scores for each modality were compiled for each condition and are included in Figure 7. Consistent with expectations, participants were more successful in evaluating the models' knowledge when the correct model was also correct during the Model Evaluation Competency phase as shown by the higher scores for each modality in Condition 1, when Model A was correct and Condition 3, when Model B was correct. Participants were less successful in choosing the correct model when this model was previously incorrect during the Model Evaluation Competency phase as shown by the lower scores for each modality in Condition 2, when Model B was correct and Condition 4, when Model A was correct.

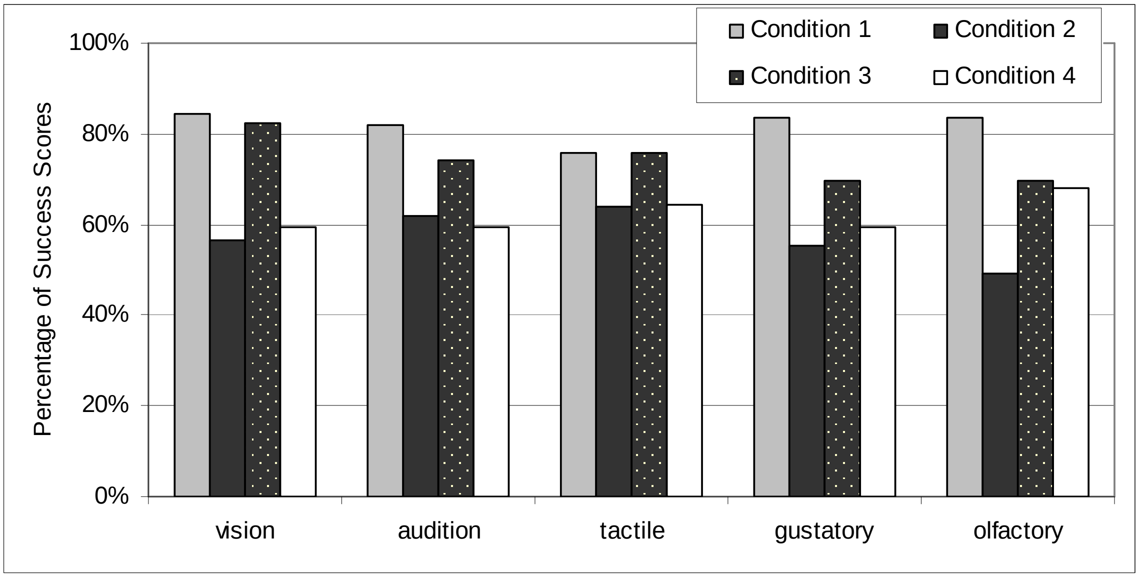


Figure 7. Successful Evaluation of Models for Each Modality of Each Condition During Testing Phase

Results from the Primary Analyses for each Research Question

The results in this section reflect the outcomes of each of the hypotheses for the three research questions. The three research questions were as follows:

Q1 What are the differences between 4- and 5-year-olds' understandings of knowledge about physical objects?

Q2 What knowledge is related to children's understanding of knowledge about physical objects?

Q3 Are there differences in children's understanding of how knowledge about physical objects is acquired based on the modality?

Research Question One

The first research question was designed to assess age differences in children's understanding of knowledge about physical objects. I hypothesized that after 4- and 5-

year-olds directly acquire knowledge and then watch 2 model children acquire knowledge about the same objects, both groups would be able to successfully evaluate the models' knowledge. An ANOVA was conducted to assess for age differences on the total score of the Model Competency Evaluation phase. The 4-year-old group averaged 8.28 out of a total possible score of 10 and the 5-year-old group averaged 8.64 for this score. As predicted, there were no significant differences between 4- and 5-year-olds' total scores on the Model Competency Evaluation phase ($F(1, 174) = 2.89$, $p = 0.09$).

However, age differences were predicted when 4- and 5-year-olds were unable to directly acquire knowledge and were instead required to acquire knowledge indirectly by evaluating each model's knowledge based on which model had appropriate perceptual access during the Testing phase. I hypothesized that 4-year-old children in Conditions 2 and 4 would be more likely to choose the model that was previously reliable, as opposed to the model that had appropriate perceptual access. In contrast, I hypothesized that 5-year-old children would be more likely to choose the model that had appropriate perceptual access regardless of the model's previous reliability.

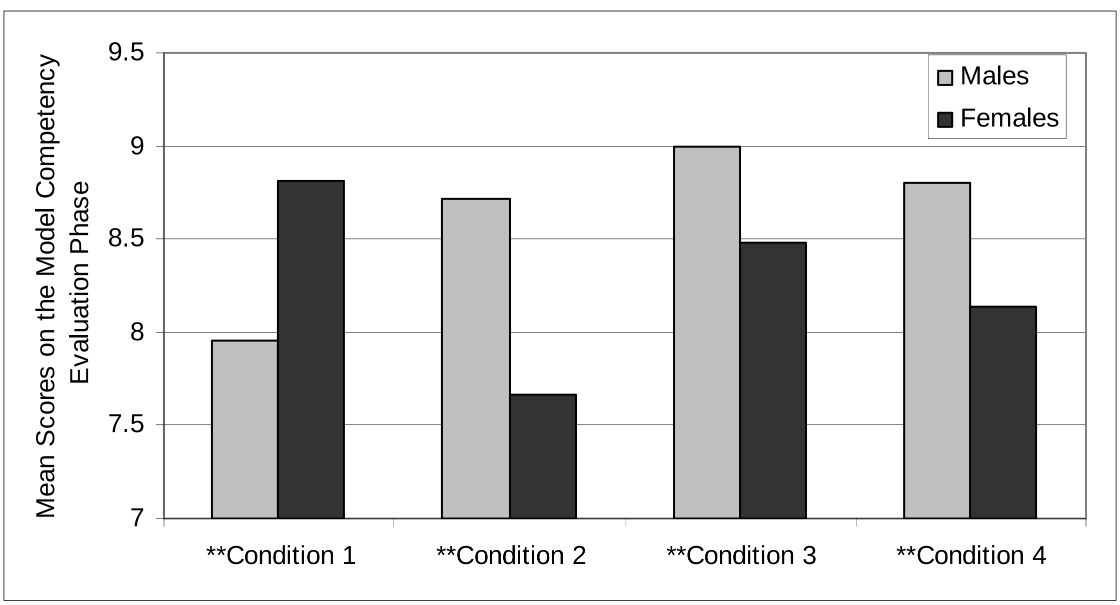
A MANOVA is an appropriate procedure to test these hypotheses based on the research design of this study. This procedure is appropriate to study more than one dependent variable at once. In addition, it is necessary to have more cases than dependent variables in every cell (Tabachnick & Fidell, 2007). The MANOVA in this study was run in order to analyze the differences between the 32 different cells which include the scores for the 2 dependent variables for each of the 3 independent variables. The cases-to-dependent variables ratio was appropriate because there were between 8 and 14 cases in each of the cells, which is more than the 2 dependent variables (see Table 5).

Based on a post hoc MANOVA power analysis, the sample size of 176 participants was adequate (Mueller & Barton, 1989; Mueller, LaVange, Ramey, & Ramey, 1992; see Appendix K for MANOVA results).

The MANOVA also includes a set of statistical assumptions. One assumption of the MANOVA is that the results of each of the dependent variables are normally distributed within groups. Based on the Levene's Test of Equality of Error Variances, which tests the null hypothesis that the error variance of each dependent variable is equal across groups, the assumption of normality was violated. A MANOVA assumes that variances in the different groups are identical so the homogeneity of the variance-covariance matrices was assessed. The results of Box's M Test of Equality of Covariance Matrices were significant indicating the covariance matrices are significantly different; therefore, the assumption for homogeneity of variances was also violated. The MANOVA assumes linear relationships among dependent variables within a particular cell. This is particularly important because if the relationship is nonlinear then the results of the MANOVA may underestimate the strength of a relationship between variables or simply not detect such a relationship. Curvilinear patterns and outliers were assessed. Upon reviewing the scatter plots, there were no obvious curvilinear relationships among the variables.

As a result of the statistical violations of the MANOVA, two separate ANOVAs were computed in order to assess for age and condition differences for the Model Competency Evaluation score and the Testing total score. Similar to the MANOVA, ANOVA assumes independence, a normal distribution, and homogeneity of variances. Despite violations to these statistical assumptions, the hypotheses related to this research question (i.e., What are the differences between 4- and 5-year-olds' understandings of knowledge about physical objects?) can be tested more robustly with the two ANOVAs. A 2 x 2 x 4 (gender x age x condition) ANOVA assessed differences on the Model Competency Evaluation total score. Consistent with expectations, there was not a significant main effect of gender ($F(1, 160) = 3.60$, $p = 0.06$), nor was there a significant main effect of condition ($F(3, 160) = 1.25$, $p = 0.30$) or age ($F(1, 160) = 4.04$, $p = 0.05$) on the total score of the Model Competency Evaluation phase.

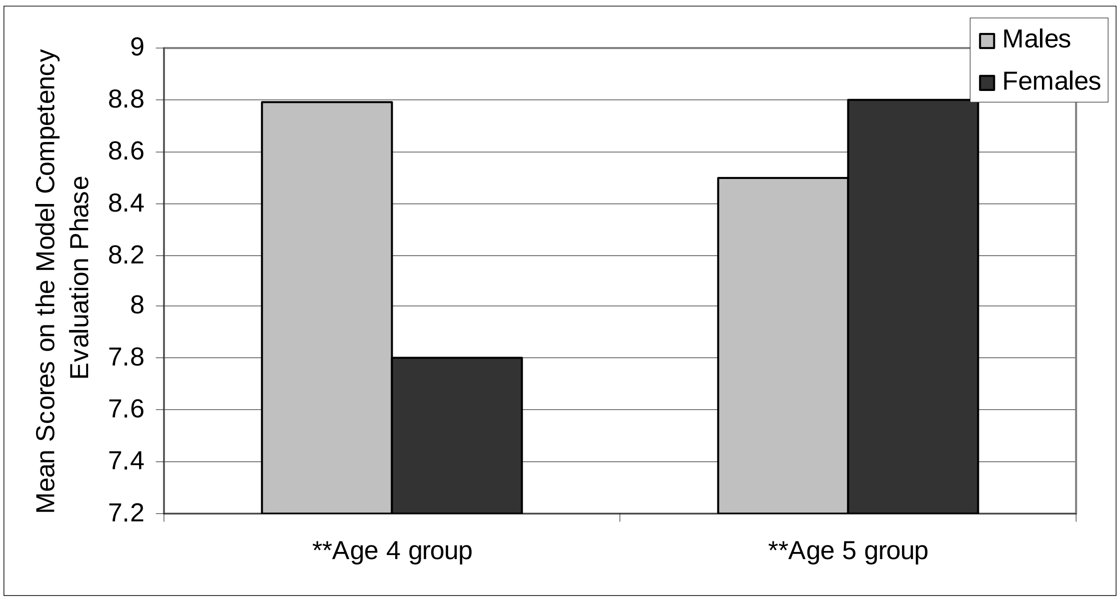
A significant interaction was detected between gender and condition ($F(3, 160) = 3.85$, $p < 0.01$). Boys outperformed girls in Conditions 2, 3, and 4 whereas girls outperformed boys in Condition 1 during the Model Competency Evaluation phase (see Figure 8). Individual scores in each of these groups were quite varied. For example, 4-year-old girls in Condition 2 had a mean score of 6.82, whereas 5-year-old girls in Condition 1 had a mean score of 9.30.



**Condition and gender interactions were significant at the 0.01 level.

Figure 8. Model Competency Evaluation Mean Scores Based on Condition and Gender

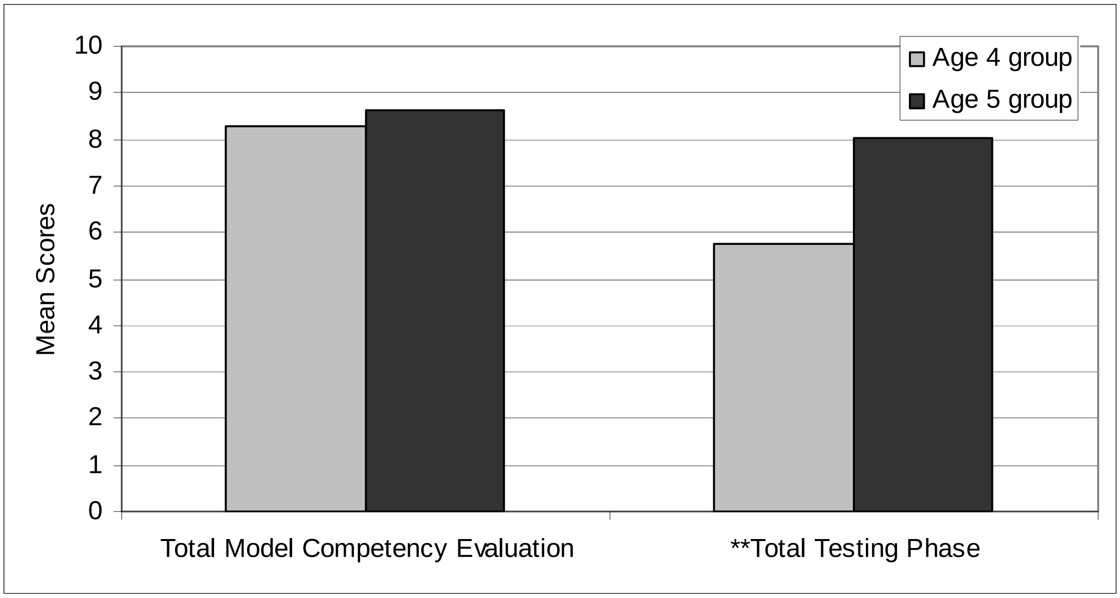
A significant interaction also was detected between gender and age ($F(1, 160) = 10.01$, $p < 0.01$). Based on mean scores on the Model Competency Evaluation total score, 4-year-old boys outperformed the same age girls and 5-year-old girls outperformed the same age boys (see Figure 9). As predicted, there was not a significant interaction between condition and age during the Model Competency Evaluation phase ($F(3, 160) = 1.14$, $p = 0.33$).



**Age and gender interactions were significant at the 0.01 level.

Figure 9. Model Competency Mean Scores Based on Age and Gender

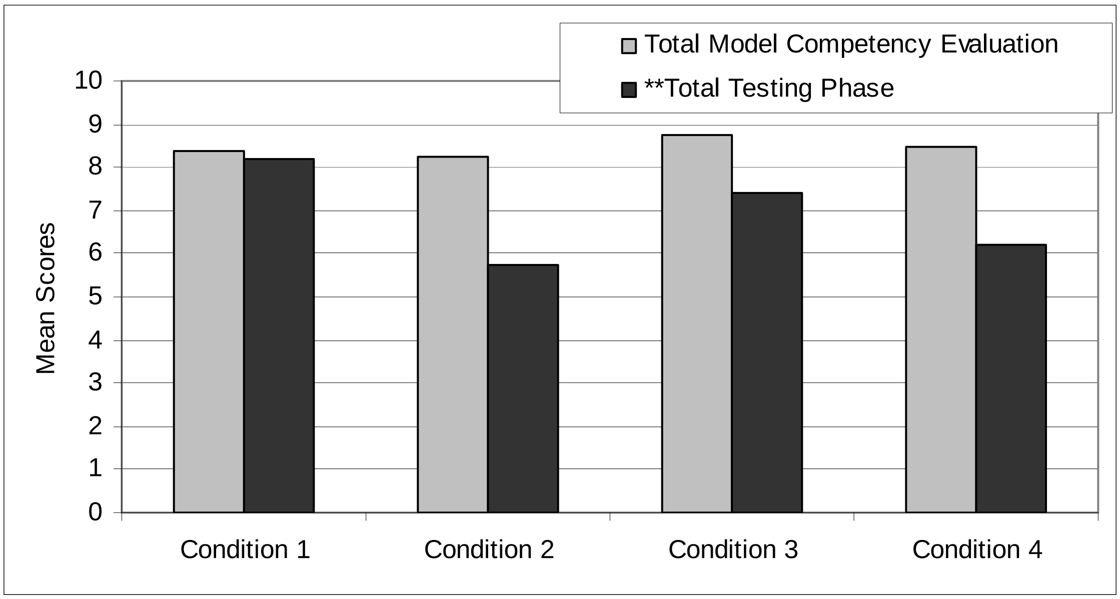
A 2 x 2 x 4 (gender x age x condition) ANOVA was computed to assess differences on the Testing phase total score. Consistent with expectations, there was not a significant main effect of gender ($F(1, 160) = 2.32$, $p = 0.13$). Also consistent with hypotheses, there was a significant main effect of age ($F(1, 160) = 27.57$, $p < 0.01$) on the total Testing scores (see Figure 10). Five-year-olds significantly outperformed 4-year-olds regardless of condition or gender.



**Age differences were significant at the 0.01 level.

Figure 10. Model Competency Evaluation and Total Testing Mean Scores Based on Age

Consistent with predictions, there was a significant main effect of condition (F(3, 160) = 6.18, p < 0.01) on the total Testing scores (see Figure 11). Regardless of age and gender, participants in Conditions 1 and 3 outperformed participants in Conditions 2 and 4. As expected, participants were more successful in choosing the accurate model during the Testing phase when this model was also accurate during the Model Competency Evaluation phase (i.e., Conditions 1 and 3) than when this model was inaccurate during the previous phase (i.e., Conditions 2 and 4). The distribution of the Testing phase scores for participants in Conditions 1 and 3 was positively skewed. There were no significant Testing phase score differences between participants in Condition 1 (M = 8.19, SD = 2.63, n = 42) and Condition 3 (M = 7.43, SD = 2.75, n = 46; t(86) = 1.32, p = 0.19). Forty-three percent of the participants in Condition 1 earned a perfect score and 39% of participants in Condition 3 earned a perfect score. The distribution of the scores for participants in Conditions 2 and 4 were rather flat and normal. There were no significant performance differences between participants in Condition 2 (*M* = 5.74, *SD* = 3.49, *n* = 46) and Condition 4 (*M* = 6.21, *SD* = 3.35, *n* = 42; *t*(86) = -0.65, *p* = 0.52). Twenty-four percent of the participants in Condition 2 earned a perfect score and 19% of participants in Condition 4 earned a perfect score.



**Condition differences were significant at the 0.01 level.

Figure 11. Model Competency Evaluation and Total Testing Mean Scores Based on Condition

As predicted, there was no significant interaction between gender and age ($F(1, 160) = 1.95$, $p = 0.16$) or gender and condition ($F(3, 160) = 0.06$, p = 0.98). I predicted an interaction between age and condition but this relationship was not statistically significant ($F(3, 160) = 0.45$, $p = 0.72$).

Even though there was no significant interaction between age and condition on total Testing scores, Figure 12 shows the mean scores for each age group and in each condition. The 4- and 5-year-old groups performed better during Conditions 1 and 3 than Conditions 2 and 4. Recall that Condition 2 and Condition 4 are more challenging because children are required to inhibit their previous belief of who was reliable and evaluate the model peer that has appropriate perceptual access. In contrast, the peer that was previously reliable in Condition 1 and Condition 3 is the same peer that has appropriate perceptual access during the Testing phase.

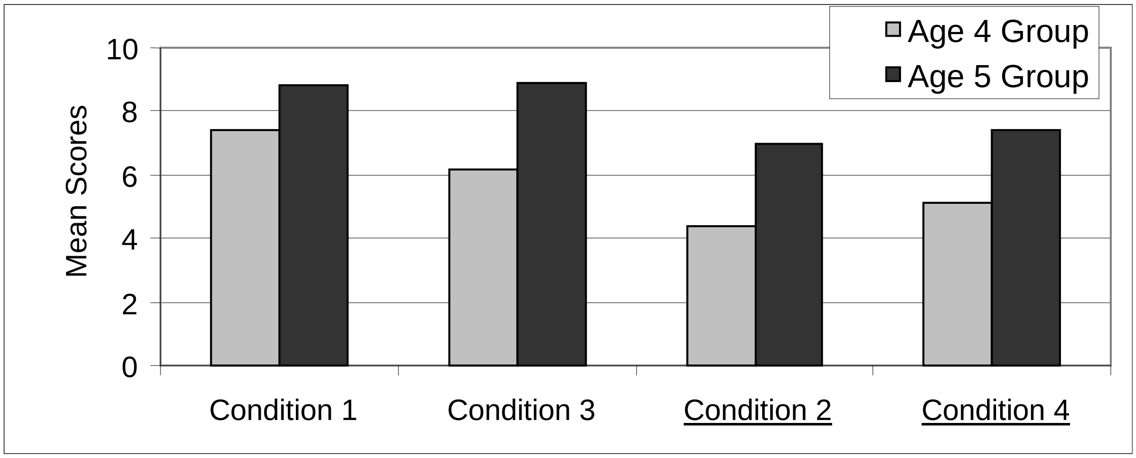


Figure 12. Total Testing Phase Mean Scores by Age and Condition

Research Question Two

The second research question was designed to assess what knowledge is related to children's understanding of knowledge about physical objects. I predicted that children who could explicitly identify which sensory organ they used when directly acquiring modality-specific knowledge would be more successful in assessing another's modality-specific knowledge acquisition than children who do not know the source of their knowledge. A positive correlation between the total score on the five (i.e., one question for each modality resulting in a possible range of 0 to 5) "how did you know that?" questions during the Model Competency Evaluation phase and the total score on the Testing phase (i.e., two questions for each modality resulting in a possible range of 0 to 10) was predicted. There was a significant positive correlation between children's ability to identify how they identified modality-specific knowledge of physical objects and their ability to identify who has accurately acquired modality-specific knowledge for physical objects they do not investigate (r (175) = 0.235, $p < 0.01$). It should be noted that age was significantly related to children's how scores (r (175) = 0.245, $p < 0.01$), and age was significantly related to total score on the Testing phase (r (175) = 0.308, $p < 0.01$), suggesting that age mediates both scores.

Research Question Three

The third research question was designed to assess modality differences in children's understanding of knowledge about physical objects. During the Model Competency Evaluation phase, children were most successful in understanding vision-specific knowledge. As predicted, however, children incorrectly reported that they used their eyes more than any other sensory organ, suggesting an overestimation of the value of sight. Table 10 shows the number of times each sensory organ was chosen when participants were asked how they acquired knowledge during each modality-specific trial.

Table 10

Frequency of Sensory Organs Identified When Asked How They Acquired Modality-Specific Knowledge for Each Trial During the Model Competency Evaluation Phase

	Sensory Organ					
Trial	Eyes	Ears	Hands	Mouth	Nose	Other
Vision	148	12	9	5	2	0
Audition	10	144	7	11	3	1
Tactile	40	6	119	10	1	0
Gustatory	9	5	14	145	3	0
Olfactory	77	14	23	16	40	6
Total *f*	284	181	172	187	49	7

Do children who correctly identify modality-specific knowledge also overestimate sight? The response patterns for those that *correctly* identified modality-specific knowledge about physical objects are depicted in Table 11. After acquiring and sharing correct modality-specific knowledge, children seem to overestimate the use of their eyes. For example, after sharing accurate auditory-specific knowledge about the song on the compact disc player, 10 participants incorrectly indicated that they acquired this information from their eyes, an impossible feat! Collapsing across trials, children overestimated the knowledge acquired from their eyes 68 times whereas they overestimated the knowledge acquired from their nose only 8 times.

Children who acquired and shared accurate modality-specific knowledge were most successful in identifying how they acquired visual-specific, gustatory-specific, and auditory-specific knowledge and least successful in identifying how they acquired tactile-specific and olfactory-specific knowledge. Eighty-five percent of those who correctly claimed that the viewfinder contains an image of a train, correctly claimed they used their eyes to acquire this information. Similarly, 85% of those who identified the contents of the opaque mug based on a flavor (i.e., liberal scoring procedure), correctly claimed they used their mouth to acquire this information. Eighty-three percent of those who correctly claimed that the song being played by the compact disc player was the Happy Birthday song, correctly claimed they used their ears to acquire this information. Interestingly, only 68% of those who correctly identified the spoon during the tactile trial also correctly claimed that they used their hands to acquire this information. Furthermore, only 33% of those who identified the contents of the bubble bath container based on a scent (i.e., liberal scoring procedure), correctly claimed they used their nose to acquire this information.

Table 11

Frequency of Sensory Organs Identified When Asked How They Acquired Modality-Specific Knowledge for Each Trial After Acquiring Correct Knowledge During the Model Competency Evaluation Phase

	Sensory Organs					
Trial	Eyes	Ears	Hands	Mouth	Nose	Other
Vision	147	12	9	4	2	0
Audition	10	143	6	10	3	1
Tactile	40	6	118	8	1	0
Gustatory[a]	6	4	11	133	2	0
Olfactory[a]	12	2	4	2	11	2
Total *f*	215	167	148	157	19	3

[a]Frequency of responses based on the liberal scoring procedure.

Response patterns of those who correctly identified modality-specific knowledge but incorrectly identified the sensory organ they used to acquire this knowledge are depicted in Figure 13. Similar to Table 11, Figure 13 includes data that are based on the liberal scoring procedure for the gustatory and the olfactory trials. The liberal scoring procedure for the gustatory and olfactory trials accounted for participant responses that were based on a flavor or a scent and therefore consistent with the modalities being questioned. The liberal scoring procedure was adopted for these trials to account for participants that may be unable to identify the exact flavor or scent but whom otherwise investigated the modality-specific contents appropriately. Despite utilizing modality-specific objects that have been used in the past with preschoolers (see Cooper, 2007;

Norton, 2003; O'Neill & Chong, 2001), participants may have been unable to identify the exact flavor or scent based on limited exposure to such flavors or scents.

Participants incorrectly claimed they used their eyes more than any of the other sensory organs. This finding further supports the hypothesis that children overestimate the power of sight.

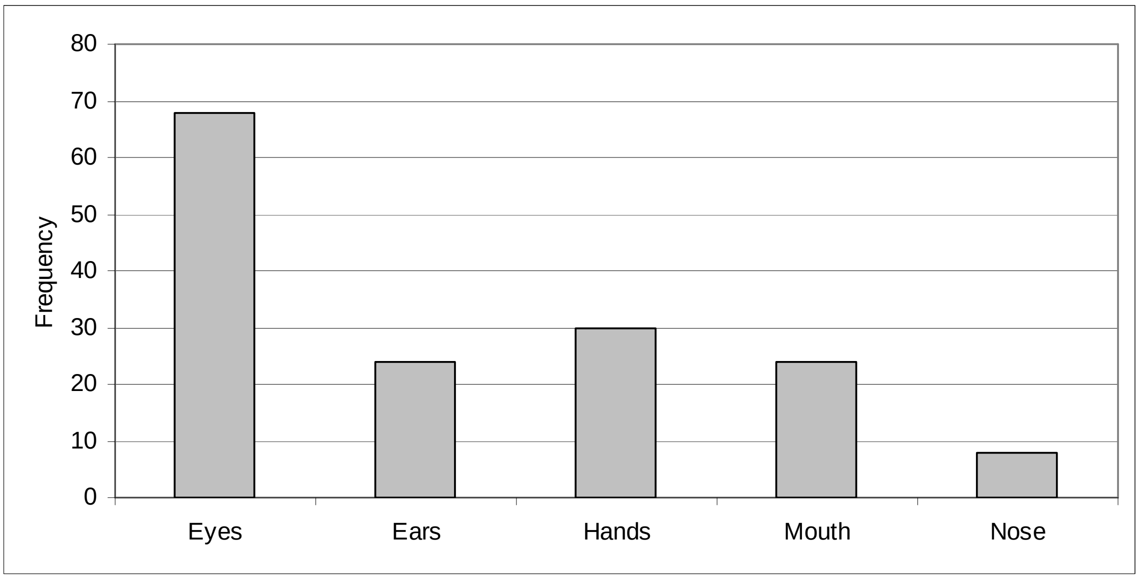


Figure 13. Frequency with which Participants Erroneously Chose Sensory Organs During How Trials After Acquiring Correct Knowledge During the Model Competency Evaluation Phase

Are there age differences in children's overestimation of sight? Figure 14 shows the frequency with which 4- and 5-year-olds' incorrectly chose the sensory organ they used after correctly acquiring modality-specific knowledge. Similar to Figure 13, data in Figure 14 are based on the liberal scoring procedure for the gustatory and olfactory trials. Therefore, participants who identified the contents of the mug based on a flavor and participants who identified the contents of the bubble bath based on a scent were included as correct respondents in this figure. Four-year-old children overestimate the use of their eyes more than 5-year-old children.

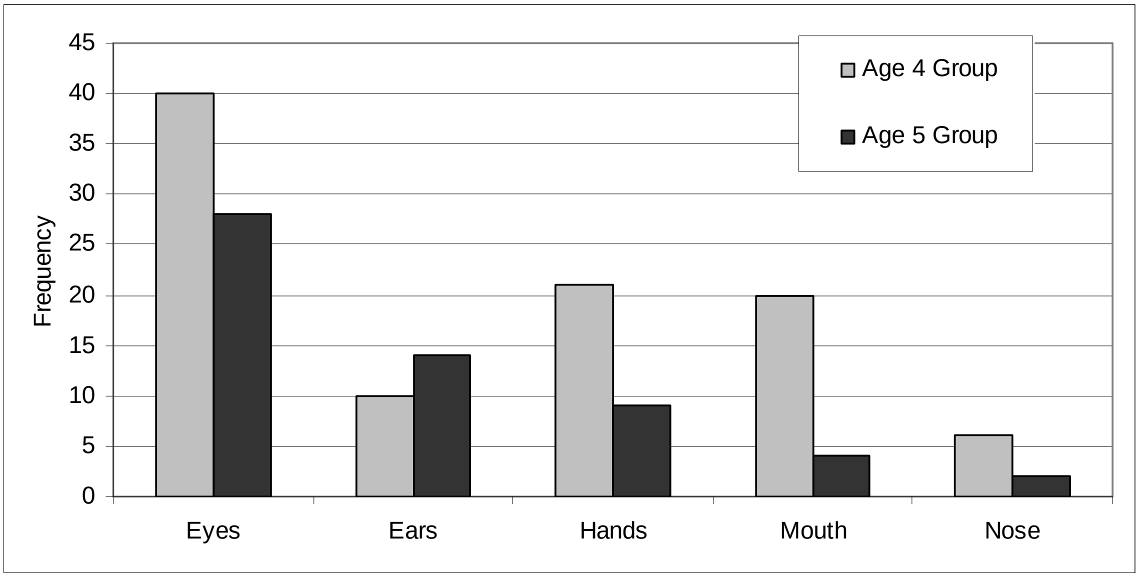


Figure 14. Frequency of Times Participants Erroneously Chose Sensory Organs During How Trials After Acquiring Correct Knowledge During the Model Competency Evaluation Phase by Age Group

What are the age differences in understanding modality-specific knowledge about physical objects during the Testing phase? Total scores on the visual-specific, auditory-specific, tactile-specific, gustatory-specific, and olfactory-specific trials (i.e., two questions for each modality resulting in a possible range of 0 to 2 for each score) during the Testing phase were calculated for each participant and are shown as Table 12. The 5-year-old group outperformed the 4-year-old group in demonstrating knowledge of each of the modalities.

In order to assess for significant age differences in modality understanding, a 2 x 5 (age x modality) ANOVA was computed on each of the five modality-specific knowledge scores from the testing phase. There were significant age differences for each of the modality scores ($p < 0.01$) except for the tactile scores ($F(1, 175) = 6.38$, $p = 0.012$).

Table 12

Means and Standard Deviations for Modality Scores of the Testing phase by Age

Trials		Age 4 Group	Age 5 Group
**Visual	*M*	1.13	1.70
	SD	0.86	0.63
**Auditory	*M*	1.19	1.58
	SD	0.77	0.62
*Tactile	*M*	1.26	1.55
	SD	0.80	0.69
**Gustatory	*M*	1.06	1.61
	SD	0.89	0.63
**Olfactory	*M*	1.11	1.57
	SD	0.85	0.77

* Age difference is significant at the 0.05 level.
** Age differences are significant at the 0.01 level.

Results from the Secondary Analyses

The results in this section reflect secondary analyses of data from the Model Competency Evaluation phase and the Testing phase. Participant commentary during the task and additional results from each of the modality-specific trials are included. In addition, the relationships between the length of time participants had been attending preschool and their performance during the Model Competency Evaluation phase and the Testing phase are included.

Model Competency Evaluation Phase

This phase was designed to assess children's ability to directly acquire modality-specific knowledge, identify how they acquired the knowledge, and then evaluate the accuracy of two models after each attempted to acquire the same modality-specific knowledge. The 4-year-olds and 5-year-olds evaluated models' knowledge similarly ($F(1, 174) = 2.89$, $p = 0.09$). Both groups performed quite well, as expected, but there appears to be differences in their successful acquisition of knowledge, identification of how knowledge was acquired, and their evaluations of the two models depending on the modality. The following includes a description of participants' performances during the different modality trials to add insight to the results from the Model Competency Evaluation phase.

Vision Trial. Consistent with expectations, participants were quite successful in identifying vision-specific information and knowing how they acquired such information. Only 2 of the 176 participants were incorrect when identifying that the contents of the viewfinder was a train. Eighty-four percent of the participants correctly indicated that they used their eyes when acquiring this information.

Audition Trial. Only 3 of the 176 participants were incorrect when identifying that the contents of the compact disc player was the happy birthday song. Eighty-two percent of the participants correctly indicated that they used their ears when acquiring this information.

Tactile Trial. Participants were also quite successful in acquiring tactile-specific knowledge. Only 3 of the 176 participants were incorrect when identifying that the content of an opaque bag was a spoon.

Many of the participants acquired this knowledge by using more than one sensory organ. Slightly more than half of the participants (i.e., 51% or 89 out of 176 participants) used their hands and their eyes to correctly acquire this knowledge. Of these cross-modal knowledge seekers, 51 (57%) participants reported that they used their hands, 30 (34%) participants reported that they used their eyes, and the remaining 8 (9%) were incorrect when they were asked how they learned that there was a spoon in the bag.

The response patterns of the participants (i.e., 49% or 87 out of 176 participants) who only used their hands when acquiring tactile-specific knowledge were also assessed. Seventy-eight percent of this group correctly claimed they used their hands.

Gustatory Trial. Eighty-nine percent (i.e., 156 out of 176 participants) of the participants correctly identified the contents of the opaque mug by a flavor. This high success rate is based on the liberal scoring procedure. When the scoring criterion was more rigorous so that participants were scored as correct only when they identified the contents of the mug as apple juice, only 102 of the 176 participants or 58% correctly identified the contents as apple juice.

Some participants appeared reluctant to taste the contents of an opaque, covered mug when offered by the experimenter. Seventeen of the participants did not try the drink during the taste trial. These participants may have been reluctant to try the drink because the experimenter was not familiar to the participants, and children may be concerned about consuming a drink from someone who is less familiar. Furthermore, participants may have also been reluctant to consume a drink that may have a noxious taste. Participants were not allowed to explore the contents by taking off the cover of the mug in order to look at or smell the contents of the mug.

Fifty-seven of the participants were unable to identify the exact contents during the taste trial (e.g., apple juice). Three of these participants indicated that they did not know even after tasting the drink multiple times. The remaining participants offered 18 different drink responses. The most frequent incorrect response was orange juice (18 participants), followed by lemonade (11 participants) and grape juice (7 participants).

Interestingly, 47% of the participants who were unable to identify the exact contents during the taste trial indicated that the model that correctly identified the drink as apple juice had correct knowledge. In contrast, 53% of those who were unable to identify the exact drink contents indicated that the correct model was incorrect. This suggests that approximately half of children were able to recognize that the model who consumed the beverage was accurate. In contrast, the model who looked at the outside of the cup, which was similar to their investigation, was inaccurate.

Eighty-two percent of the participants correctly indicated that they used their mouth in order to identify the contents of the cup. Therefore, despite the large variability in participants' beliefs about the contents of the cup, almost all were able to correctly report on how taste-specific knowledge should be acquired.

Olfactory Trial. There were a variety of responses when participants were asked to identify the type of bubble bath. The most common response was "I don't know" (38 out of 176 participants). The second most common response was that the bubble bath was "green" (26 out of 176 participants) and the third most common response was that the bubble bath was "blue" (17 out of 176 participants). It is important to note that the container was blue and the bubble bath was yellow resulting in a greenish tinge to the liquid when looking at the contents from the outside of the container.

Following the liberal scoring procedure, only 19% (33 out of 176 participants) of the participants correctly identified the contents of the opaque container by a scent. Based on the liberal scoring procedure, any responses reflecting a scent were coded as correct. For example, participants that identified the contents as “coconut,” “cherry apple juice,” “grape,” or “blueberry” were scored as correct. When the criterion was more rigorous so that participants were scored as correct only when they identified the type of bubble bath as lemon bubble bath, only 3 of the 176 participants correctly identified the contents as lemon bubble bath.

Only 23% (40 out of 176 participants) of the participants claimed that they used their nose when asked how they found out what kind of bubble bath it was. The most common response was that they used their eyes. Forty-four percent of the participants (77 out of 176 participants) indicated that they used their eyes.

Length of Time in a Preschool Program. There was a positive correlation between children’s evaluations of the accuracy of the two models and the length of time they participated in a preschool program (r (165) = 0.157, p = 0.44). In addition, there was a significant positive correlation between children’s ability to identify how they acquired modality-specific knowledge and the length of time they participated in a preschool program (r (165) = 0.223, p < 0.01).

Testing Phase

In order to compare participants’ performances between the two trials for each modality and to generally compare performances among the different modality trials, Figure 15 is included. Interestingly, the audition trials had quite discrepant results from each other. Participants were least successful in determining which model correctly determined whether the radio was projecting music or people talking, whereas participants were most successful in determining which model correctly identified the song played by the music toy. In contrast, success rates were most similar during the olfactory trials.

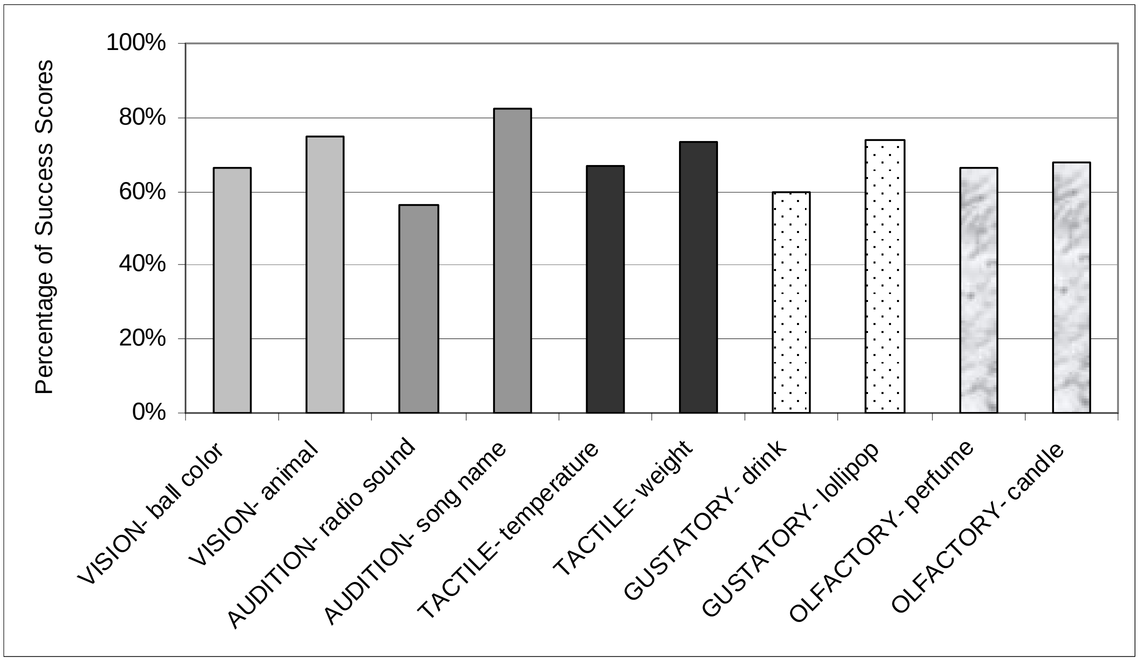


Figure 15. Success Rates for Each Trial During the Testing Phase

In order to assess whether there was a relationship among the modality scores, gamma coefficients were calculated. Goodman and Kruskal's (1954) gamma coefficient is a measure of association for determining the relationship between two ordinally scaled variables. Gamma coefficients were tabulated for each combination of two modality-specific knowledge scores (range for each score = 0-2) from the Testing phase. All pairings were positively associated indicating that there was a high probability for two modality-specific understanding scores to rank order two persons in similar ways. For example, if a participant earned a visual-specific knowledge score of 1 then he is likely to also earn an auditory-specific knowledge score of 1, as opposed to 0 or 2. In addition, all pairings were rather strongly associated indicating that there were close to perfect agreements between some modality-specific knowledge scores. The strongest pairings were the following: visual-specific and gustatory-specific (Γ = 0.823), visual-specific and olfactory-specific (Γ = 0.821), and gustatory-specific and olfactory-specific (Γ = 0.807). The weakest pairings were the following: auditory-specific and tactile-specific (Γ = 0.621), visual-specific and tactile-specific (Γ = 0.713), and auditory-specific and gustatory-specific (Γ = 0.718).

The relationship between total testing phase score and length of preschool participation was assessed. There was a slight positive correlation between children's evaluations of the accuracy of the two models during the Testing phase and the length of time they participated in a preschool program (r (165) = 0.061, p = 0.44).

Summary of Results

Both 4- and 5-year-olds were quite successful in evaluating the knowledge of two model peers after directly acquiring knowledge and identifying how that knowledge was acquired. Children were less successful in acquiring gustatory-specific and olfactory-specific knowledge than in acquiring vision-specific, audition-specific, and tactile-specific knowledge. Older children were more successful in identifying which sensory organ they used when acquiring modality-specific knowledge but both groups overestimated the use of their eyes.

In order to explore how 4- and 5-year-olds would evaluate model peers' knowledge when their direct knowledge acquisition was restricted, the testing phase was instituted. Five-year-olds were significantly more likely to identify which model had appropriate perceptual access than were 4-year-olds. Both groups, however, were more likely to learn from the peer that was previously reliable than from the peer that had appropriate perceptual access. Children were most successful evaluating another's knowledge when the peer that was previously reliable also had appropriate perceptual access as opposed to when the peer that was previously reliable did not have appropriate perceptual access.

CHAPTER V

DISCUSSION

Summary and Interpretations of the Main Findings

Research Question One

Evaluations of Others' Knowledge. As predicted, after directly acquiring modality-specific knowledge about 5 different objects, both 4- and 5-year-old children were quite successful in evaluating the accuracy of another's knowledge (e.g., 4-year-olds were 83% successful and 5-year-olds were 86% successful). This finding is consistent with previous research (Birch et al., 2008; Clément et al., 2004; Jaswal & Neely, 2006; Koenig et al., 2004; Koenig & Harris, 2005; Pasquini et al., 2007).

Unexpectedly, there was a significant interaction between gender and condition during the Model Competency Evaluation phase. Boys outperformed girls in Conditions 2, 3, and 4 whereas girls outperformed boys in Condition 1.

In addition, there was a significant interaction between gender and age during the Model Competency Evaluation phase. Four-year-old boys outperformed 4-year-old girls whereas 5-year-old girls outperformed 5-year-old boys. It is possible that younger girls were less interested in the computer technology employed in the study or had less computer expertise than their male counterparts or older girls and therefore their scores were constrained by their low computer interest or decreased knowledge. I completed all of the manipulations of the computer during the task unless the participant requested to "push the button." More boys requested to operate the computer than girls. Another explanation is that younger girls may have more difficulty in evaluating the expertise of those who are different from them than do older girls.

Children's Subscriptions to Previously Accurate Model or Model with Appropriate Perceptual Access. Critically evaluating whether the model has appropriate perceptual access is a necessary skill that 4- and 5-year-olds must employ to be successful during the Testing phase of the task. In contrast to the Model Competency Evaluation phase, the Testing phase required children to indirectly acquire knowledge from a model peer. Five-year-olds were significantly more successful than 4-year-olds in evaluating the knowledge acquisition procedure of the two models during the Testing phase. This finding supports previous research in which children's understanding of the relationship between appropriate perceptual access and knowledge improves between 4 and 5 years of age (Chandler & Helm, 1984; O'Neill et al., 1992; Norton, 2003; Taylor, 1988).

Regardless of age, children who were faced with a peer who was previously incorrect but who now had appropriate perceptual access performed significantly worse than those who were faced with a peer who was previously correct and who had appropriate perceptual access during the Testing phase. Therefore, 4- and 5-year-olds evaluate a peer's knowledge based more on whether a peer was previously reliable rather than whether the peer has appropriate perceptual access to acquire accurate knowledge.

This finding contributes to the conflicting evidence as to whether preschoolers interpret another's reliability as variable or stable. Nurmsoo and Robinson (2009) found evidence that 3- to 5-year-olds will subscribe to the testimony of a previously unreliable informant if that informant was unreliable because he did not have appropriate informational access. In contrast, when faced with an informant who was unreliable despite having informational access, preschoolers trusted their own guess and ignored the informant. Scofield and Behrend (2008) found that 27% of 3-year-olds and 54% of the 4-year-olds in their study chose to reverse trust in a previously reliable informant who later proved unreliable. Nurmsoo and Robinson (2009) found that children did not defer to an informant who was previously unreliable because he was blindfolded but who now had appropriate visual access to label a familiar object.

Research Question Two

Relationship Between How Do You Know and Evaluation of Others' Knowledge. Children's ability to identify the source of their knowledge improves significantly between 4 and 6 years of age (Drummey & Newcombe, 2002; Gopnik & Graf, 1988). Therefore, I predicted that children who explicitly knew which sensory organ was the source of their own modality-specific knowledge would be more successful in assessing another's modality-specific knowledge acquisition than children who did not know the source of their knowledge. Children's ability to identify which sensory organ was necessary to acquire modality-specific knowledge about objects was significantly, positively related to their ability to evaluate others' knowledge about the same objects.

Children who acquired accurate knowledge were more successful in evaluating the expertise of others than children who acquired inaccurate knowledge or who did not attempt to acquire modality-specific knowledge. Based on this finding, children may have learned that they can evaluate the accuracy of another's knowledge by merely comparing another's response to their own. If children are simply enacting some form of recognition memory, which requires less cognitive resources than recall memory, or applying their memory of the modality-specific knowledge to a novel problem, they may be less likely to critically evaluate each model's knowledge acquisition procedure. Perhaps it is necessary to engage children's higher-order thinking in order to initiate more sophisticated critical evaluations as to why another's knowledge is accurate or not. For example, children's critical thinking may have been primed if they were supported to call to mind the function of each of the sensory organs. The calling to mind procedure has been used in previous research to explain how the process of considering mistaken beliefs may help children learn accurate beliefs (Kloos & Somerville, 2001; Kloos & Van Orden, 2005).

Similar to Gopnik and Graf's (1988) finding, in which between 3- and 5-years of age children are increasingly able to identify the source of their knowledge (also see Drummey & Newcombe, 2002), this study found a significant relationship between age and ability to identify how information is acquired.

Research Question Three

Source Monitoring Ability Based on the Modality. Four-year-olds have been found to be more successful in understanding the source of visual-specific knowledge than other modality-specific sources of knowledge (Gopnik & Graf, 1988; Norton, 2003; O'Neill & Gopnik, 1991; Weinberger & Bushnell, 1994; Wimmer et al., 1988). I predicted that children would be more successful in evaluating the accuracy of visual-specific knowledge than auditory-specific, tactile-specific, olfactory-specific, and gustatory-specific knowledge.

Children who acquired and shared accurate modality-specific knowledge were most successful in identifying how they acquired visual-specific, gustatory-specific, and auditory-specific knowledge and least successful in identifying how they acquired tactile-specific and olfactory-specific knowledge. Children were most successful in evaluating the knowledge of others' visual-specific, tactile-specific, and auditory-specific knowledge and slightly less successful in evaluating others' gustatory-specific and olfactory-specific knowledge.

As predicted, children's understanding of the different modalities improved with age. There were significant age differences for each of the modality understanding scores except for the tactile scores during the Testing phase. Children directly investigate objects and indirectly acquire information from others about objects every day. Over time, these experiences along with their developing understanding about the causal relationship between perceptual access and knowledge promote children's understanding about the differences between the modalities.

Overestimation of Sight. After correctly acquiring and sharing modality-specific knowledge, 4-year-old children were more likely than 5-year-old children to incorrectly claim they used their eyes in order to acquire information about objects. This finding is consistent with previous research and the hypothesis that young children overestimate the knowledge acquired through sight (Cooper, 2007; Fabes & Filsinger, 1986; Robinson et al., 1997; Weinberger & Bushnell, 1994). This result may be due to their overall poor source encoding, as Perner (1991) would suggest and others have found (O'Neill & Chong, 2001; O'Neill & Gopnik, 1991).

What does it mean to overestimate knowledge from sight? Young children incorrectly attributed knowledge to others who had visual access to objects and who visually perceived some of the objects' attributes. Some attributes can be discovered based on visual inspection, other attributes cannot. In order to evaluate others' knowledge, young children must discern between which attributes require visual exploration and which require a different sensory exploration.

Why do preschoolers overestimate what can be learned by sight? Preschoolers may automatically represent knowledge in the visual domain after acquiring new information in another domain. There seems to be an automatic encoding of tactile-specific knowledge in the visual perception system beginning at an early age. For example, 4-month-old infants who only manually explored a toy were able to identify the toy based only on vision (Streri & Spelke, 1988). In the present study, tactile-specific knowledge scores were based on children's understandings of how to determine the temperature of water in a bowl and the weight of a piggy bank. Children may have extensive experience representing the temperature and weight of objects in their visual perceptual systems and therefore concluded that the model without visual access is incorrect. It may be that children's intermodal perceptions in these two modalities result in a visual representation of tactile-specific information beginning at an early age.

Another explanation for children's overestimation of what may be learned by sight may be that children overly depend on their sense of sight because visually exploring objects oftentimes result in accurate knowledge about non-visual specific information. There appears to be a reliance on one's sight when acquiring olfactory-specific knowledge. Children were more likely to identify the contents of the bubble bath based on a visual-specific attribute (e.g., green, blue) rather than an olfactory-specific attribute (e.g., coconut, cherry apple juice, grape, and blueberry). Forty-four percent of the participants (i.e., 77 out of 176 participants) indicated that they used their eyes. In addition, children may have acquired knowledge about the scent of the bubble bath by looking at the attributes of the bubble bath container and therefore they developed a false belief about the scent of the bubble bath because of visual information. For example, children may have falsely surmised that the bubble bath was blueberry because the container was blue. Keep in mind that the stimuli were intentionally designed so that the only way to acquire modality-specific knowledge was to employ one specific sensory organ.

Another explanation of children's overestimation of the power of sight is that children, especially younger children, engage in a simple heuristic in which seeing leads to knowing. If this heuristic is adopted, then children may superficially explore objects visually and evaluate others' knowledge based on whether others explore objects visually. Beginning at a young age, infants learn to follow their mother's line of vision in order to "know" what their mother is thinking about (D'Entremont et al., 1997; Scaife & Bruner, 1975). However, infants' knowledge of what their mother is thinking about is not as developed as preschoolers but the power of sight and its initial relationship to knowledge is established from this early stage in life. This initial relationship between sight and knowledge may gradually develop between 4- and 6-years of age into a more sophisticated understanding that only particular knowledge can be acquired through sight.

Limitations of the Study

One limitation of this study is that both model peers were boys. I intentionally included models of the same gender in order to reduce differential responding based on this attribute. It is possible that participants would have interpreted gender differences between the two models as a potential source for differences in knowledge. For example, the female model may have been more adept at identifying the type of perfume whereas the male model may have been more adept at identifying the color of the ball. This intentional limitation may have led to gender differences in performance during the Model Competency Evaluation phase. Boys outperformed girls in 3 of the 4 Conditions of this phase. This suggests that boys may have related more to the peers potentially resulting in increased attention to the male peer's behavior and therefore more successful evaluations. A similar interpretation can be applied to the finding that regardless of condition, 4-year-old boys outperformed girls. In contrast, 5-year-old girls (88% successful) slightly outperformed the 5 year-old boys (85% successful). By 5 years of age, both genders performed quite well during this task suggesting that the gender effect is mitigated for older children who seem to be quite adept at evaluating others' knowledge.

Another limitation is the generalizability of the findings based on the sample included. The sample was recruited from private preschools. A majority of the preschools were in neighborhoods and included children that would be considered medium to high-medium socioeconomic status.

Children's performance may be partially explained by their preschool curriculum. Performance may vary based on curriculum elements such as the availability of objects to explore and instruction on how to explain the results of the explorations. Performance may also vary based on the program's focus on critical thinking. Appendix J is a set of descriptions of some preschool sites from which children were recruited. There is not adequate data to draw conclusions regarding the relative emphasis on scientific inquiry or critical thinking in the curricula of the participating preschools.

Children's performance may be partially explained by their verbal intelligence. Language ability was not assessed during this study. Previous research has found that 4-year-old children are able to label each of the sensory organs (Cooper, 2007) as well as identify the sensory activity relating to each of the sensory organs (Weinberger & Bushnell, 1994). In order to be successful on the task, children were required to receptively understand the meaning of the sensory attribute in question and associate that attribute with the appropriate sensory organ. For example, children were required to understand terms such as "weight" and "temperature" and relate these attributes to tactile exploration. It is not clear if children were familiar with these terms.

Children's performance may also be partially explained by the communicative characteristics of their home environment. Performance may vary based on the sophistication of explanations that parents offer when asked about the source of their knowledge. Performance may also vary based the frequency of parents' questions and comments about children's knowledge, beliefs, and guesses. Relevant data on child-rearing conditions were not gathered as a part of this study.

Children may have had limited motivation to assess peers' knowledge during the Testing phase. The knowledge they indirectly acquired from the model during this second phase of the task was not to be generalized such as to use the information to solve a problem or complete a goal; nor was this knowledge something that they were particularly curious about. It is possible that children would be more critical of the model's knowledge-gathering abilities if the knowledge they acquired were more generalizable.

Contributions to the Literature

Children learn a tremendous amount of information from their peers. This study assessed children's evaluations of same-age peers' knowledge and thus has greater validity than previous research that has assessed children's evaluations of adults, puppets, or animated characters (e.g., Birch et al., 2008; Clément et al., 2004; Koenig et al., 2004; Koenig & Harris, 2005; Nurmsoo & Robinson, 2009; Pasquini et al., 2007; Robinson, Champion, & Mitchell, 1999; Robinson & Nurmsoo, 2009; Scofield & Behrend, 2008).

The present study is unique in describing children's understanding of informant knowledge about all 5 sensory modalities. Previous work has included 1 or 2 different sensory modalities (Nurmsoo & Robinson, 2009; Robinson & Whitcombe, 2003) or 3 different sources of information such as another's testimony, another's clue, or one's own observation (Gopnik & Graf, 1988). Therefore, this study offers more comprehensive information about children's understanding of knowledge than does previous research.

This study allowed children to more comprehensively evaluate the reliability of informants than previous research. In this study, children's reliability assessments of others were based on 5 trials whereas previous studies typically include only 3 trials (e.g., Harris, 2007). This methodological change may have allowed children to build a stronger profile of the informants' trustworthiness.

Unlike previous research that has assessed children's ability to learn the labels of unfamiliar objects (Birch et al., 2008; Jaswal & Neely, 2007; Koenig et al., 2004; Koenig & Harris, 2005; Sabbagh & Baldwin, 2001; Scofield & Behrend, 2008) or the function of objects (Birch) from an informant, this study assessed children's ability to learn about the sensory-specific characteristics of relatively familiar objects and toys. As such, it expands our overall understanding of the types of information that children learn from others.

Based on the procedure adopted in this study, I was able to uniquely assess whether preschoolers trust a peer who was previously accurate *or* a peer who has appropriate perceptual access. In addition, the procedure adopted and the stimuli employed in the study allowed me to comprehensively assess children's source monitoring ability and understanding of modality-specific knowledge acquired directly and indirectly from others.

Recommendations for Further Research

Future research can assess children's ability to evaluate their assuredness. It is unclear as to whether assuredness is a stable, person-specific trait or a variable trait based on the question at hand (e.g., the specific modality in question). Interestingly, 47% of the participants who were unable to identify the exact contents during the taste trial indicated that the model that correctly identified the drink as apple juice had correct knowledge. In contrast, 53% of those who were unable to identify the exact drink contents indicated that the correct model was incorrect. These data suggest that approximately half of children do not have absolute resolve in their knowledge in that they may defer to another's knowledge. A future study could include an additional measure in which children report on the level of assuredness of their knowledge when acquiring information directly and when learning from others. In addition, the general assuredness of each participant could be measured separately by participants' parents and teacher. These additional assuredness measures could then be used to help explain differences in children's performance on the task used in this study.

Children's interpretations of the inaccurate model were not thoroughly probed in the present study. Procedural steps were taken in order to minimize the differences between the two models such as the number of words spoken by each model and the affect displayed by each model. More stable characteristics of the models chosen were also considered. For example, the speech articulation ability of each model, the attractiveness of each model, and the height of each model were also considered so that both models were similar in each domain. Future research can investigate interpretations of the inaccurate model to determine whether children consider idiosyncratic differences between peers when determining who to trust.

Future research can require children to use the information they learn from others in order to solve a problem or complete a goal. By requiring children to use the new information, children's attention to others' knowledge-seeking behavior and their motivation to acquire accurate information may be improved. For example, in order to complete an obstacle course that ends with the discovery of a prize, children must adopt the advice of one of two informants to overcome the obstacles. Both informants are motivated to help but only one, during each step, has appropriate informational access to offer credible advice. Another way to incorporate this methodological change is to include two informants who are motivated to help the participant discover a prize but who offer different strategies in order to do so. For example, one informant may tell the child to get information about a toy's location or the next clue from the person who is wearing the mouth mask, who cannot talk but can use his hands to point in the correct direction, and the other informant may tell the child to get information from the person who is wearing the oven mitts, who can talk but cannot use his hands. This methodology may be adopted in order further assess children's understandings about the differences between the sensory modalities.

Do children view one's trustworthiness as domain-specific or domain-general? Future research could assess whether children ascribe trustworthiness to others across domains. The present study was designed to assess children's evaluations of others' knowledge about physical objects and did not assess children's evaluations of others' knowledge about non-physical objects or beliefs. Nor did this study allow children to assess others' skills to build a sense of trustworthiness about their skills such as play skills versus problem-solving abilities.

Do children refer to one's trustworthiness as a stable or variable trait? The comments that children shared during this study offered insights into their reasoning as to what led to the informant being correct or incorrect. This information can be categorized as to commentary that seems to support trustworthiness as a stable or a variable trait. For example, he's wrong "because he doesn't tell the truth," "he keeps telling a lie," "he doesn't know anything," and "he was born with a bad brain." Others claimed that the informant was "smart" or "super smart," and "I think he is really smart[er] than the green boy." Each of these statements seems to suggest that the informant's expertise is a stable attribute but future research could more formally evaluate children's perceptions about the stability of this trait.

Children's trustworthiness of others may be based on their dispositions. People may be "high trusters" or "low trusters" (Hardin, 2002). The existence of a trust/distrust trait at this age was assessed based on the results of this study. There were 6 children who incorrectly claimed that both peers were correct and 3 children who incorrectly claimed that both peers were incorrect during the Model Competency Evaluation phase. The results of this study do not offer overwhelming support for this interpretation of how children evaluate others' knowledge but it does suggest that some 4- and 5-year-old children may be overly trusting or overly skeptical of others without fully considering why another can or cannot be trusted.

Future research can also evaluate children's working memory in order to assess the relationship between children's executive function skills and understanding of modality-specific knowledge. In order to be successful during this task, children were required to evaluate others' knowledge based on their understanding of the causal relationship between appropriate perceptual access and sensory-specific knowledge about objects. In addition, children may have monitored the peers' responses in order to construct what Harris (2007) refers to as a trustworthiness profile. This trustworthiness profile could have guided the child in determining whether the peers were trustworthy or not. A trustworthiness profile may have alleviated some of the cognitive demands of the task. For example, during the Testing phase, children in Conditions 2 and 4 may have merely chosen the peer with the strongest trustworthiness profile (i.e., the peer that was previously accurate during the Model Competency Evaluation phase) rather than the peer with appropriate perceptual access. However, in order to be successful, children in Conditions 2 and 4 were required to ignore peers' previous performance and instead diligently observe the knowledge acquisition procedures that the peers employed to determine which peer had appropriate perceptual access and used the appropriate sensory organ in order to acquire modality-specific knowledge. Therefore, children in Conditions 2 and 4 were faced with extensive cognitive demands which may have affected their performance.

Implications for Education

The results of the present study provide practical insight as to whether 4- and 5-year-old children can shift their epistemic trust from a peer who was previously accurate to a peer who was not. This finding is important because, although it would be efficient to simply defer to a peer who has been previously trustworthy, social and cognitive problems may arise if children do not critically consider whether that person could conceivably have accurate knowledge. If children accept another's false assertion, they may act on this inaccurate information which may result in negative social ramifications. For example, after witnessing a child act on faulty information, a peer may infer that the child has less intelligence and therefore the peer may not choose to partner with the child to complete a task or play a game. Furthermore, children who simply defer to a peer's false assertions may be viewed as gullible which may make them susceptible to being taken advantage of by peers. A child who acts on faulty information may become frustrated when trying to solve a problem or complete a task or may be penalized by the teacher or peers if the child is unsuccessful with the problem or task. Based on the results of this study, even though many 5-year-olds were able to shift their epistemic trust to a previously unreliable peer, both 4- and 5-year-olds generally value a peer's previous reliability over appropriate perceptual access when acquiring knowledge about objects.

This study was designed in part to assess children's understanding that modality-specific knowledge about physical objects is based on perceptual access. This understanding is critical for children to efficiently acquire knowledge about objects on their own and when indirectly acquiring knowledge from others. In the classroom, it is important that children understand that perceptual access can be variable in that peers that previously had appropriate informational access earlier in the day or during one activity may not have appropriate informational access later in the day or during a different activity.

Children must appreciate a basic epistemic tenet that appropriate perceptual access results in knowledge prior to engaging in more critical evaluations of knowledge that characterize later schooling. For example, it is important for older children to be able to evaluate whether a website is an accurate and reliable source of knowledge. In addition, older children need to be able to critically evaluate whether various sources such as a teacher, friend, textbook, or magazine are accurate and reliable sources of knowledge to cite when writing a paper.

Based on the explanations that children provided during the task, there were multiple strategies that children employed in order to identify the accurate informant. Strategies included: identifying which peer had appropriate perceptual access regardless of the sensory inhibitor worn, identifying which peer had appropriate perceptual access by acknowledging that the sensory inhibitor worn does not affect perceptual access, identifying which peer had appropriate perceptual access by default after commenting on the peer that has inappropriate perceptual access, identifying the peer that was not wearing a sensory inhibitor that would interfere with appropriate perceptual access, and identifying the incorrect peer based on the sensory inhibitor worn.

Some of the children's strategies were more adaptive than others. Many children, especially those who were more successful during the task, referred to the observable behavior of the informants likely to determine whether the informants had appropriate perceptual access in that moment. Children highlighted the importance of having appropriate perceptual access when commenting on why the informant was correct: "he looked," "he could see," "he used his eyes and he knew," "he can hear it," "he lifted it up," "he used his hands," "he could feel it," "he dranked it," "he tasted it with his mouth," "this one drinked the water," and "you let him smell it." Some children acknowledged the sensory inhibitors that the informant was wearing and could explain whether that affected the informant's knowledge acquisition: "he has his ears blocked but he could still see," "he can have that on his eyes but he could still hear," "he had this on [his] eyes and he put his hand in water," "he couldn't see but he could feel it," and "he had the blindfold on and he got to smell it." In other cases, children compared why one informant had perceptual access and another did not: "he didn't see it and he did," "he had his mouth and this guy has his mouth closed," "he had the eye thing on and the other one had that thing so he couldn't smell," and "he had his nose plugged and he just had his eyes covered." In other instances, children reported on why one was correct based merely on not having the sensory inhibitor that the other informant had: "he didn't have that thing on his eyes," "he doesn't have the blindfold," "they didn't cover his ears," "he didn't have his ears plugged up," and "he didn't wear gloves." Lastly, some children reported only on why an informant was incorrect suggesting that they rule out the incorrect informant first and simply refer to the other as correct by default: “he didn’t even feeling anything through those things,” “you put the mouth thing on him,” “this guy had the nose plugger on,” and “he was wrong because he had these on so he couldn’t smell.”

All of the above comments shed light on children’s emerging understanding about the relationship between appropriate perceptual access and knowledge about objects. The differences in the children’s comments also highlight the differences in the reasoning ability of children. For example, after noticing that one informant’s mouth was covered, children should come to the decision that he does not know the taste of the lollipop but they should not merely rule in favor of the other informant by default. Teachers may need to support children in order to help them critically consider whether classmates have appropriate informational access to acquire accurate knowledge.

Children’s thinking about how they acquired knowledge and analyses of where knowledge comes from can be fostered while at school. In fact, Kuhn argues that “the development of epistemological understanding may be the most fundamental underpinning of critical thinking” (Kuhn, 1999, p. 23). Children may benefit from opportunities to discuss and analyze their reasoning with their teacher about various discoveries they make while at school.

Children may benefit from classroom activities designed to build memory strategies and source monitoring ability. In the present study, there were some children who chose the model with appropriate perceptual access during the Testing phase but reported incorrect reasons as to why the model was correct. For example, one participant correctly claimed the model who picked up the piggy bank was correct but then said he was right, "because he said it was heavy." This explanation is incorrect; the correct model actually said the piggy bank was "light!" Additionally, after indicating that the model without the nose pincher correctly acquired information about the type of perfume, one child said, "he smelled it and it smelled like flowers." The correct model actually said that the perfume smelled like vanilla, whereas the incorrect model indicated that the perfume smelled like flowers. These comments suggest that children may benefit from learning experiences that require them to reflect on their memory of how they acquired new knowledge.

Some of the explanations that children offered highlight unsophisticated reasoning as to why one informant was correct and the other was incorrect. For example, many children simply repeated the responses of the correct model: "he said cheetah," "because [the water] is cold," "I think it's light," "he said cherry," and "he said vanilla." In another case, after choosing the correct model during one of the vision trials, one child indicated that the model was correct "because he's happy." One child's statement highlighted children's difficulty in explaining why a model was correct or incorrect when he said, "I don't know why but he always wins." These explanations suggest that children's ability to justify their reasoning is emerging during the preschool years. Children may benefit from experiences that require them to critically evaluate their interpretations of others' actions.

Other explanations were faulty regardless of children's accuracy in responding. For example, one child stated, "you have to be able to *smell* things to *see* what they *taste* like." During one of the olfactory trials of the testing phase, a child stated that the model wearing the nose pincher was wrong “because he can’t breathe.” These comments suggest that children can benefit from experiences that require them to compare, contrast, and explain how information is acquired from each of the senses.

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APPENDIX A

MATRIX OF CONDITIONS WITH RESEARCH QUESTIONS AND INTERPRETATIONS

MATRIX OF CONDITIONS WITH RESEARCH QUESTIONS AND INTERPRETATIONS

	CONDITION TYPE	n	MODEL COMPETENCY EVALUATION PHASE	Who should I believe based on model competency evaluation?	TESTING PHASE	Who should I believe based on testing?	Who should I believe based on weighing both equally?	Interpretations
1	Model A Reliable & access	42	Model A = accurate Model B = inaccurate	A	Model A = access Model B = no access	A	A	
2	Model A Reliable & no access	46	Model A = accurate Model B = inaccurate	A	Model A = no access Model B = access	B	A or B	If A then previous reliability outweighs perceptual access. If B then perceptual access outweighs previous reliability.
3	Model B Reliable & access	46	Model A = inaccurate Model B = accurate	B	Model A = no access Model B = access	B	B	
4	Model B Reliable & no access	42	Model A = inaccurate Model B = accurate	B	Model A = access Model B = no access	A	A or B	If B then previous reliability outweighs perceptual access. If A then perceptual access outweighs previous reliability.

APPENDIX B

MODEL COMPETENCY EVALUATION PHASE SCORE SHEET

ID:_________ Condition:_________

MODEL COMPETENCY EVALUATION PHASE SCORE SHEET

Sensory-modality	Modality-specific stimuli	Identify Content			
		Participant: What is it? Participant object knowledge (0-5)	Participant: How did you learn that? Participant source knowledge (0-5)	Model A: Right (1) or Wrong (0)? Participant evaluation of another's knowledge (0-5)	Model B: Right (1) or Wrong (0)? Participant evaluation of another's knowledge (0-5)
Vision	Viewfinder- Thomas the Train- "train"				
Audition	Headphones- Mickey Mouse tunes- "happy birthday song"				
Tactile	Opaque quilted bag- spoon- "spoon"				
Taste	Opaque covered cup with straw- apple juice- "apple juice"				
Olfactory	Opaque open container- lemon bubble bath- "lemon"				
TOTAL		Acquiring Perceptual Knowledge Directly (0-5)	Understanding of Perceptual Source of Directly Acquired Knowledge (0-5)	Evaluation of Model A's knowledge (0-5)	Evaluation of Model B's knowledge (0-5)
				Model Competency Eval. Phase Score (0-10)	

APPENDIX C

TESTING PHASE SCORE SHEET

ID:_________ Condition:___________

TESTING PHASE SCORE SHEET

Sensory-modality	Model without perceptual access will wear:	Model with perceptual access will wear:	Knowledge Questions	Which answer to knowledge question does participant choose?		Modality-Specific Scores	
				Model A	Model B		
Vision	Eye Mask	Ear Muffs	What color is the ball?				
			What kind of animal is it?				
Audition	Ear Muffs	Eye Mask	What sound comes from the radio?				
			What song does the toy play?				
Tactile	Oven Mitts	Eye Mask	What temperature is the water?				
			What is the weight of the piggy bank?				
Taste	Doctor's Mask	Eye Mask	What kind of water is it?				
			What kind of lollipop is it?				
Olfactory	Swimmer Nose Pincher	Eye Mask	What kind of perfume is it?				
			What kind of candle is it?				
TOTAL						Testing Phase Score: (0-10)	

APPENDIX D

SCRIPTS FOR ACTORS

SCRIPTS FOR ACTORS

	CONDITION TYPE	MODEL COMPETENCY EVALUATION PHASE	TESTING PHASE
1	Model A Reliable & access	Model A = accurate	Model A = access
		Model B = inaccurate	Model B = no access

Model Competency Evaluation:

(Clip 1MCE-1A) Viewfinder is on table. Experimenter asks, "What is in the viewfinder?" Experimenter picks up viewfinder and holds it up. Model A leans forward, looks inside, and then says, "train."
(Clip 1MCE-1B) Viewfinder is on table. Experimenter asks, "What is in the viewfinder?" Experimenter picks up viewfinder and holds it towards Model B. Model B holds the viewfinder, looks at the outside, and then says, "cars."

(Clip 1MCE-2A) Headphones connected to compact disc player are on table. Experimenter asks, "What song is being played?" Experimenter picks up headphones and puts on model's ears. Model A listens and then says, "Happy Birthday song."
(Clip 1MCE-2B) Headphones connected to compact disc player are on table. Experimenter asks, "What song is being played?" Experimenter picks up headphones and offers the headphones to Model B. Model B ignores the experimenter, looks at the compact disc player, and then says, "The Wheels on the Bus."

(Clip 1MCE-3A) Cloth bag containing a spoon is on the table. Experimenter asks, "What is in the bag?" Model A reaches his hand inside the bag, feels what is inside, and then says, "spoon."
(Clip 1MCE-3B) Cloth bag containing a spoon is on the table. Experimenter asks, "What is in the bag?" Model B looks at the bag and then says, "plastic bags."

(Clip 1MCE-4A) Opaque cup with cover and straw is on the table. Experimenter asks, "What is in the cup?" Model A leans down, sips from the straw, and then says, "apple juice."
(Clip 1MCE-4B) Opaque cup with cover and straw is on the table. Experimenter asks, "What is in the cup?" Model B touches the cup and then says, "coffee."

(Clip 1MCE-5A) Small plastic bubble bath container without lid is on the table. Experimenter asks, "What kind of bubble bath is it?" Model A leans down towards top of container, sniffs, and says, "lemon."
(Clip 1MCE-5B) Small plastic bubble bath container without lid is on the table. Experimenter asks, "What kind of bubble bath is it?" Model B looks at the container and says, "strawberry."

Testing Phase:

(Clip 1T-1A) Opaque container with no top is on the table. Model A is wearing ear muffs. Experimenter says, “There is a ball in the bag. What color is the ball?” Model A leans over, looks into the container, and says, “yellow.”
(Clip 1T-1B) Opaque container with no top is on the table. Model B is wearing an eye mask. Experimenter says, “There is a ball in the bag. What color is the ball?” Model B leans over, looks into the container with covered eyes, and says, “red.”

(Clip 1T-2A) Shopping bag with open top is on the table. Model A is wearing ear muffs. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model A leans over, looks into the bag, and says, “cheetah.”
(Clip 1T-2B) Shopping bag with open top is on the table. Model B is wearing an eye mask. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model B leans over, looks into the bag with covered eyes, and says, “duck.”

(Clip 1T-3A) Small radio is on the table. Model A is wearing an eye mask. Experimenter asks, “What sound is coming from the radio?” Model A leans over so that an ear is close to the radio, listens to radio, and says, “people talking.”
(Clip 1T-3B) Small radio is on the table. Model B is wearing ear muffs. Experimenter asks, “What sound is coming from the radio?” Model B leans over so that a covered ear is close to the radio, listens to radio, and says, “music.”

(Clip 1T-4A) Small children’s musical toy is on the table. Model A is wearing an eye mask. Experimenter asks, “What song does the toy play?” Model A leans over so that an ear is close to the musical toy, listens to the toy, and says, “Twinkle, Twinkle Little Star.”
(Clip 1T-4B) Small children’s musical toy is on the table. Model B is wearing ear muffs. Experimenter asks, “What song does the toy play?” Model B leans over so that a covered ear is close to the musical toy, listens to the toy, and says, “Old MacDonald had a Farm.”

(Clip 1T-5A) Small plastic bowl containing water is on the table. Model A is wearing an eye mask. Experimenter asks, “What temperature is the water?” Model A reaches his arm out, touches the water, and says, “cold.”
(Clip 1T-5B) Small plastic bowl containing water is on the table. Model B is wearing oven mitts. Experimenter asks, “What temperature is the water?” Model B reaches his arm out, while wearing the oven mitt touches the water, and says, “warm.”

(Clip 1T-6A) Porcelain piggy bank is on the table. Model A is wearing an eye mask. Experimenter asks, “What is the weight of the piggy bank?” Model A reaches his arm out, picks up the bank, and says, “light.”
(Clip 1T-6B) Porcelain piggy bank is on the table. Model B is wearing oven mitts. Experimenter asks, “What is the weight of the piggy bank?” Model B reaches his arm out, tries to pick up bank, looks at bank, and says, “heavy.”

(Clip 1T-7A) Red lollipop is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of lollipop is it?” Experimenter holds up lollipop towards Model A. Model A licks lollipop and says, “cherry.”
(Clip 1T-7B) Red lollipop is on the table. Model B is wearing a doctor’s mask. Experimenter asks, “What kind of lollipop is it?” Experimenter holds up lollipop towards Model B. Model B leans towards lollipop, looks at it, and says, “strawberry.”

(Clip 1T-8A) A plastic child’s cup containing water and straw is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of water is it?” Model A leans down, drinks from straw, and says, “salty.”
(Clip 1T-8B) A plastic child’s cup containing water and straw is on the table. Model B is wearing a doctor’s mask. Experimenter asks, “What kind of water is it?” Model B leans down towards straw, looks at water, and says, “plain.”

(Clip 1T-9A) Perfume spray bottle containing vanilla extract is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of perfume is it?” Experimenter then pushes nozzle on top of spray bottle to release liquid. Model A leans down, smells the liquid, and then says, “vanilla.”
(Clip 1T-9B) Perfume spray bottle containing vanilla extract is on the table. Model B is wearing swimmer’s nose pincher. Experimenter asks, “What kind of perfume is it?” Experimenter then pushes nozzle on top of spray bottle to release liquid. Model B leans down towards container, looks at it, and then says, “flowers.”

(Clip 1T-10A) Small red candle is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of candle is it?” Model A leans down towards candle, sniffs, and says, “apple.”
(Clip 1T-10B) Small red candle is on the table. Model B is wearing swimmer’s nose pincher. Experimenter asks, “What kind of candle is it?” Model B leans down towards candle, looks at it, and says, “cherry.”

	CONDITION TYPE	MODEL COMPETENCY EVALUATION PHASE	TESTING PHASE
2	Model A Reliable & no access	Model A = accurate	Model A = no access
		Model B = inaccurate	Model B = access

Model Competency Evaluation:

(Clip 2MCE-1A) Viewfinder is on table. Experimenter asks, “What is in the viewfinder?” Experimenter picks up viewfinder and holds it up. Model A leans forward, looks inside, and then says, “train.”
(Clip 2MCE-1B) Viewfinder is on table. Experimenter asks, “What is in the viewfinder?” Experimenter picks up viewfinder and holds it towards Model B. Model B holds the viewfinder, looks at the outside, and then says, “cars.”

(Clip 2MCE-2A) Headphones connected to compact disc player are on table. Experimenter asks, “What song is being played?” Experimenter picks up headphones and puts on model’s ears. Model A listens and then says, “Happy Birthday song.”
(Clip 2MCE-2B) Headphones connected to compact disc player are on table. Experimenter asks, “What song is being played?” Experimenter picks up headphones and offers the headphones to Model B. Model B ignores the experimenter, looks at the compact disc player, and then says, “The Wheels on the Bus.”

(Clip 2MCE-3A) Cloth bag containing a spoon is on the table. Experimenter asks, “What is in the bag?” Model A reaches his hand inside the bag, feels what is inside, and then says, “spoon.”
(Clip 2MCE-3B) Cloth bag containing a spoon is on the table. Experimenter asks, “What is in the bag?” Model B looks at the bag and then says, “plastic bags.”

(Clip 2MCE-4A) Opaque cup with cover and straw is on the table. Experimenter asks, “What is in the cup?” Model A leans down, sips from the straw, and then says, “apple juice.”
(Clip 2MCE-4B) Opaque cup with cover and straw is on the table. Experimenter asks, “What is in the cup?” Model B touches the cup and then says, “coffee.”

(Clip 2MCE-5A) Small plastic bubble bath container without lid is on the table. Experimenter asks, “What kind of bubble bath is it?” Model A leans down towards top of container, sniffs, and says, “lemon.”
(Clip 2MCE-5B) Small plastic bubble bath container without lid is on the table. Experimenter asks, “What kind of bubble bath is it?” Model B looks at the container and says, “strawberry.”

Testing Phase:

(Clip 2T-1A) Opaque container with no top is on the table. Model A is wearing an eye mask. Experimenter says, “There is a ball in the bag. What color is the

ball?" Model A leans over, looks into the container with covered eyes, and says, "red."
(Clip 2T-1B) Opaque container with no top is on the table. Model B is wearing ear muffs. Experimenter says, "There is a ball in the bag. What color is the ball?" Model B leans over, looks into the container, and says, "yellow."

(Clip 2T-2A) Shopping bag with open top is on the table. Model A is wearing an eye mask. Experimenter says, "There is a toy animal in the bag. What kind of animal is it?" Model A leans over, looks into the bag with covered eyes, and says, "duck."
(Clip 2T-2B) Shopping bag with open top is on the table. Model B is wearing ear muffs. Experimenter says, "There is a toy animal in the bag. What kind of animal is it?" Model B leans over, looks into the bag, and says, "cheetah."

(Clip 2T-3A) Small radio is on the table. Model A is wearing ear muffs. Experimenter asks, "What sound is coming from the radio?" Model A leans over so that a covered ear is close to the radio, listens to radio, and says, "music."
(Clip 2T-3B) Small radio is on the table. Model B is wearing an eye mask. Experimenter asks, "What sound is coming from the radio?" Model B leans over so that an ear is close to the radio, listens to radio, and says, "people talking."

(Clip 2T-4A) Small children's musical toy is on the table. Model A is wearing ear muffs. Experimenter asks, "What song does the toy play?" Model A leans over so that a covered ear is close to the musical toy, listens to the toy, and says, "Old MacDonald had a Farm."
(Clip 2T-4B) Small children's musical toy is on the table. Model B is wearing an eye mask. Experimenter asks, "What song does the toy play?" Model B leans over so that an ear is close to the musical toy, listens to the toy, and says, "Twinkle, Twinkle Little Star."

(Clip 2T-5A) Small plastic bowl containing water is on the table. Model A is wearing oven mitts. Experimenter asks, "What temperature is the water?" Model A reaches his arm out, while wearing the oven mitt touches the water, and says, "warm."
(Clip 2T-5B) Small plastic bowl containing water is on the table. Model B is wearing an eye mask. Experimenter asks, "What temperature is the water?" Model B reaches his arm out, touches the water, and says, "cold."

(Clip 2T-6A) Porcelain piggy bank is on the table. Model A is wearing oven mitts. Experimenter asks, "What is the weight of the piggy bank?" Model A reaches his arm out, tries to pick up bank, looks at bank, and says, "heavy."
(Clip 2T-6B) Porcelain piggy bank is on the table. Model B is wearing an eye mask. Experimenter asks, "What is the weight of the piggy bank?" Model B reaches his arm out, picks up the bank, and says, "light."

(Clip 2T-7A) Red lollipop is on the table. Model A is wearing a doctor's mask. Experimenter asks, "What kind of lollipop is it?" Experimenter holds up lollipop towards Model A. Model A leans towards lollipop, looks at it, and says, "strawberry."
(Clip 2T-7B) Red lollipop is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of lollipop is it?" Experimenter holds up lollipop towards Model B. Model B licks lollipop and says, "cherry."

(Clip 2T-8A) A plastic child's cup containing water and straw is on the table. Model A is wearing a doctor's mask. Experimenter asks, "What kind of water is it?" Model A leans down towards straw, looks at water, and says, "plain."
(Clip 2T-8B) A plastic child's cup containing water and straw is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of water is it?" Model B leans down, drinks from straw, and says, "salty."

(Clip 2T-9A) Perfume spray bottle containing vanilla extract is on the table. Model A is wearing swimmer's nose pincher. Experimenter asks, "What kind of perfume is it?" Experimenter then pushes nozzle on top of spray bottle to release liquid. Model A leans down towards container, looks at it, and then says, "flowers."
(Clip 2T-9B) Perfume spray bottle containing vanilla extract is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of perfume is it?" Experimenter then pushes nozzle on top of spray bottle to release liquid. Model B leans down towards container, sniffs, and then says, "vanilla."

(Clip 2T-10A) Small red candle is on the table. Model A is wearing swimmer's nose pincher. Experimenter asks, "What kind of candle is it?" Model A leans down towards candle, looks at it, and says, "cherry."
(Clip 2T-10B) Small red candle is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of candle is it?" Model B leans down towards candle, sniffs, and says, "apple."

	CONDITION TYPE	MODEL COMPETENCY EVALUATION PHASE	TESTING PHASE
3	Model B Reliable & access	Model A = inaccurate	Model A = no access
		Model B = accurate	Model B = access

Model Competency Evaluation:

(Clip 3MCE-1A) Viewfinder is on table. Experimenter asks, “What is in the viewfinder?” Experimenter picks up viewfinder and holds it towards Model A. Model A holds the viewfinder, looks at the outside, and then says, “cars.”
(Clip 3MCE-1B) Viewfinder is on table. Experimenter asks, “What is in the viewfinder?” Experimenter picks up viewfinder and holds it up. Model B leans forward, looks inside, and then says, “train.”

(Clip 3MCE-2A) Headphones connected to compact disc player are on table. Experimenter asks, “What song is being played?” Experimenter picks up headphones and offers the headphones to Model A. Model A ignores the experimenter, looks at the compact disc player, and then says, “The Wheels on the Bus.”
(Clip 3MCE-2B) Headphones connected to compact disc player are on table. Experimenter asks, “What song is being played?” Experimenter picks up headphones and puts on model’s ears. Model B listens and then says, “Happy Birthday song.”

(Clip 3MCE-3A) Cloth bag containing a spoon is on the table. Experimenter asks, “What is in the bag?” Model A looks at the bag and then says, “plastic bags.”
(Clip 3MCE-3B) Cloth bag containing a spoon is on the table. Experimenter asks, “What is in the bag?” Model B reaches his hand inside the bag, feels what is inside, and then says, “spoon.”

(Clip 3MCE-4A) Opaque cup with cover and straw is on the table. Experimenter asks, “What is in the cup?” Model A touches the cup and then says, “coffee.”
(Clip 3MCE-4B) Opaque cup with cover and straw is on the table. Experimenter asks, “What is in the cup?” Model B leans down, sips from the straw, and then says, “apple juice.”

(Clip 3MCE-5A) Small plastic bubble bath container without lid is on the table. Experimenter asks, “What kind of bubble bath is it?” Model A looks at the container and says, “strawberry.”
(Clip 3MCE-5B) Small plastic bubble bath container without lid is on the table. Experimenter asks, “What kind of bubble bath is it?” Model B leans down towards top of container, sniffs, and says, “lemon.”

Testing Phase:

(Clip 3T-1A) Opaque container with no top is on the table. Model A is wearing an eye mask. Experimenter says, “There is a ball in the bag. What color is the

ball?” Model A leans over, looks into the container with covered eyes, and says, “red.”
(Clip 3T-1B) Opaque container with no top is on the table. Model B is wearing ear muffs. Experimenter says, “There is a ball in the bag. What color is the ball?” Model B leans over, looks into the container, and says, “yellow.”

(Clip 3T-2A) Shopping bag with open top is on the table. Model A is wearing an eye mask. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model A leans over, looks into the bag with covered eyes, and says, “duck.”
(Clip 3T-2B) Shopping bag with open top is on the table. Model B is wearing ear muffs. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model B leans over, looks into the bag, and says, “cheetah.”

(Clip 3T-3A) Small radio is on the table. Model A is wearing ear muffs. Experimenter asks, “What sound is coming from the radio?” Model A leans over so that a covered ear is close to the radio, listens to radio, and says, “music.”
(Clip 3T-3B) Small radio is on the table. Model B is wearing an eye mask. Experimenter asks, “What sound is coming from the radio?” Model B leans over so that an ear is close to the radio, listens to radio, and says, “people talking.”

(Clip 3T-4A) Small children’s musical toy is on the table. Model A is wearing ear muffs. Experimenter asks, “What song does the toy play?” Model A leans over so that a covered ear is close to the musical toy, listens to the toy, and says, “Old MacDonald had a Farm.”
(Clip 3T-4B) Small children’s musical toy is on the table. Model B is wearing an eye mask. Experimenter asks, “What song does the toy play?” Model B leans over so that an ear is close to the musical toy, listens to the toy, and says, “Twinkle, Twinkle Little Star.”

(Clip 3T-5A) Small plastic bowl containing water is on the table. Model A is wearing oven mitts. Experimenter asks, “What temperature is the water?” Model A reaches his arm out, while wearing the oven mitt touches the water, and says, “warm.”
(Clip 3T-5B) Small plastic bowl containing water is on the table. Model B is wearing an eye mask. Experimenter asks, “What temperature is the water?” Model B reaches his arm out, touches the water, and says, “cold.”

(Clip 3T-6A) Porcelain piggy bank is on the table. Model A is wearing oven mitts. Experimenter asks, “What is the weight of the piggy bank?” Model A reaches his arm out, tries to pick up bank, looks at bank, and says, “heavy.”
(Clip 3T-6B) Porcelain piggy bank is on the table. Model B is wearing an eye mask. Experimenter asks, “What is the weight of the piggy bank?” Model B reaches his arm out, picks up the bank, and says, “light.”

(Clip 3T-7A) Red lollipop is on the table. Model A is wearing a doctor's mask. Experimenter asks, "What kind of lollipop is it?" Experimenter holds up lollipop towards Model A. Model A leans towards lollipop, looks at it, and says, "strawberry."
(Clip 3T-7B) Red lollipop is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of lollipop is it?" Experimenter holds up lollipop towards Model B. Model B licks lollipop and says, "cherry."

(Clip 3T-8A) A plastic child's cup containing water and straw is on the table. Model A is wearing a doctor's mask. Experimenter asks, "What kind of water is it?" Model A leans down towards straw, looks at water, and says, "plain."
(Clip 3T-8B) A plastic child's cup containing water and straw is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of water is it?" Model B leans down, drinks from straw, and says, "salty."

(Clip 3T-9A) Perfume spray bottle containing vanilla extract is on the table. Model A is wearing swimmer's nose pincher. Experimenter asks, "What kind of perfume is it?" Experimenter then pushes nozzle on top of spray bottle to release liquid. Model A leans down towards container, looks at it, and then says, "flowers."
(Clip 3T-9B) Perfume spray bottle containing vanilla extract is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of perfume is it?" Experimenter then pushes nozzle on top of spray bottle to release liquid. Model B leans down towards container, sniffs, and then says, "vanilla."

(Clip 3T-10A) Small red candle is on the table. Model A is wearing swimmer's nose pincher. Experimenter asks, "What kind of candle is it?" Model A leans down towards candle, looks at it, and says, "cherry."
(Clip 3T-10B) Small red candle is on the table. Model B is wearing an eye mask. Experimenter asks, "What kind of candle is it?" Model B leans down towards candle, sniffs, and says, "apple."

	CONDITION TYPE	MODEL COMPETENCY EVALUATION PHASE	TESTING PHASE
4	Model B Reliable & no access	Model A = inaccurate	Model A = access
		Model B = accurate	Model B = no access

Model Competency Evaluation:

(Clip 4MCE-1A) Viewfinder is on table. Experimenter asks, "What is in the viewfinder?" Experimenter picks up viewfinder and holds it towards Model A. Model A holds the viewfinder, looks at the outside, and then says, "cars."
(Clip 4MCE-1B) Viewfinder is on table. Experimenter asks, "What is in the viewfinder?" Experimenter picks up viewfinder and holds it up. Model B leans forward, looks inside, and then says, "train."

(Clip 4MCE-2A) Headphones connected to compact disc player are on table. Experimenter asks, "What song is being played?" Experimenter picks up headphones and offers the headphones to Model A. Model A ignores the experimenter, looks at the compact disc player, and then says, "The Wheels on the Bus."
(Clip 4MCE-2B) Headphones connected to compact disc player are on table. Experimenter asks, "What song is being played?" Experimenter picks up headphones and puts on model's ears. Model B listens and then says, "Happy Birthday song."

(Clip 4MCE-3A) Cloth bag containing a spoon is on the table. Experimenter asks, "What is in the bag?" Model A looks at the bag and then says, "plastic bags."
(Clip 4MCE-3B) Cloth bag containing a spoon is on the table. Experimenter asks, "What is in the bag?" Model B reaches his hand inside the bag, feels what is inside, and then says, "spoon."

(Clip 4MCE-4A) Opaque cup with cover and straw is on the table. Experimenter asks, "What is in the cup?" Model A touches the cup and then says, "coffee."
(Clip 4MCE-4B) Opaque cup with cover and straw is on the table. Experimenter asks, "What is in the cup?" Model B leans down, sips from the straw, and then says, "apple juice."

(Clip 4MCE-5A) Small plastic bubble bath container without lid is on the table. Experimenter asks, "What kind of bubble bath is it?" Model A looks at the container and says, "strawberry."
(Clip 4MCE-5B) Small plastic bubble bath container without lid is on the table. Experimenter asks, "What kind of bubble bath is it?" Model B leans down towards top of container, sniffs, and says, "lemon."

Testing Phase:

(Clip 4T-1A) Opaque container with no top is on the table. Model A is wearing ear muffs. Experimenter says, “There is a ball in the bag. What color is the ball?” Model A leans over, looks into the container, and says, “yellow.”
(Clip 4T-1B) Opaque container with no top is on the table. Model B is wearing an eye mask. Experimenter says, “There is a ball in the bag. What color is the ball?” Model B leans over, looks into the container with covered eyes, and says, “red.”

(Clip 4T-2A) Shopping bag with open top is on the table. Model A is wearing ear muffs. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model A leans over, looks into the bag, and says, “cheetah.”
(Clip 4T-2B) Shopping bag with open top is on the table. Model B is wearing an eye mask. Experimenter says, “There is a toy animal in the bag. What kind of animal is it?” Model B leans over, looks into the bag with covered eyes, and says, “duck.”

(Clip 4T-3A) Small radio is on the table. Model A is wearing an eye mask. Experimenter asks, “What sound is coming from the radio?” Model A leans over so that an ear is close to the radio, listens to radio, and says, “people talking.”
(Clip 4T-3B) Small radio is on the table. Model B is wearing ear muffs. Experimenter asks, “What sound is coming from the radio?” Model B leans over so that a covered ear is close to the radio, listens to radio, and says, “music.”

(Clip 4T-4A) Small children’s musical toy is on the table. Model A is wearing an eye mask. Experimenter asks, “What song does the toy play?” Model A leans over so that an ear is close to the musical toy, listens to the toy, and says, “Twinkle, Twinkle Little Star.”
(Clip 4T-4B) Small children’s musical toy is on the table. Model B is wearing ear muffs. Experimenter asks, “What song does the toy play?” Model B leans over so that a covered ear is close to the musical toy, listens to the toy, and says, “Old MacDonald had a Farm.”

(Clip 4T-5A) Small plastic bowl containing water is on the table. Model A is wearing an eye mask. Experimenter asks, “What temperature is the water?” Model A reaches his arm out, touches the water, and says, “cold.”
(Clip 4T-5B) Small plastic bowl containing water is on the table. Model B is wearing oven mitts. Experimenter asks, “What temperature is the water?” Model B reaches his arm out, while wearing the oven mitt touches the water, and says, “warm.”

(Clip 4T-6A) Porcelain piggy bank is on the table. Model A is wearing an eye mask. Experimenter asks, “What is the weight of the piggy bank?” Model A reaches his arm out, picks up the bank, and says, “light.”
(Clip 4T-6B) Porcelain piggy bank is on the table. Model B is wearing oven mitts. Experimenter asks, “What is the weight of the piggy bank?” Model B reaches his arm out, tries to pick up bank, looks at bank, and says, “heavy.”

(Clip 4T-7A) Red lollipop is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of lollipop is it?” Experimenter holds up lollipop towards Model A. Model A licks lollipop and says, “cherry.”
(Clip 4T-7B) Red lollipop is on the table. Model B is wearing a doctor’s mask. Experimenter asks, “What kind of lollipop is it?” Experimenter holds up lollipop towards Model B. Model B leans towards lollipop, looks at it, and says, “strawberry.”

(Clip 4T-8A) A plastic child’s cup containing water and straw is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of water is it?” Model A leans down, drinks from straw, and says, “salty.”
(Clip 4T-8B) A plastic child’s cup containing water and straw is on the table. Model B is wearing a doctor’s mask. Experimenter asks, “What kind of water is it?” Model B leans down towards straw, looks at water, and says, “plain.”

(Clip 4T-9A) Perfume spray bottle containing vanilla extract is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of perfume is it?” Experimenter then pushes nozzle on top of spray bottle to release liquid. Model A leans down, smells the liquid, and then says, “vanilla.”
(Clip 4T-9B) Perfume spray bottle containing vanilla extract is on the table. Model B is wearing swimmer’s nose pincher. Experimenter asks, “What kind of perfume is it?” Experimenter then pushes nozzle on top of spray bottle to release liquid. Model B leans down towards container, looks at it, and then says, “flowers.”

(Clip 4T-10A) Small red candle is on the table. Model A is wearing an eye mask. Experimenter asks, “What kind of candle is it?” Model A leans down towards candle, sniffs, and says, “apple.”
(Clip 4T-10B) Small red candle is on the table. Model B is wearing swimmer’s nose pincher. Experimenter asks, “What kind of candle is it?” Model B leans down towards candle, looks at it, and says, “cherry.”

APPENDIX E

INSTITUTIONAL REVIEW BOARD APPROVAL FORMS

INSTITUTIONAL REVIEW BOARD FORMS

STUDENT'S COPY

February 19, 2008

TO: Susan Collins
Gerontology

FROM: Nancy White, Co-Chair NW
UNC Institutional Review Board

RE: Expedited Review of Proposal, *Preschoolers' Understanding of the Source of Knowledge: Are Peers Reliable Contributors of Knowledge?,* submitted by Kathryn A. Cooper (Research Advisor: Mark Alcorn)

First Consultant: The above proposal is being submitted to you for an expedited review. Please review the proposal in light of the Committee's charge and direct requests for changes directly to the researcher or researcher's advisor. If you have any unresolved concerns, please contact Nancy White, School of Nursing, Campus Box 125, (x2662). When you are ready to recommend approval, sign this form and return to me.

I recommend approval as is. Susan Collins 2/20/08
Signature of First Consultant Date

The above referenced prospectus has been reviewed for compliance with HHS guidelines for ethical principles in human subjects research. The decision of the Institutional Review Board is that the project is approved as proposed for a period of one year: 3/3/08 to 3/3/09.

Nancy White 3/3/08
Nancy White, Co-Chair Date

Comments:

UNIVERSITY of
NORTHERN COLORADO

UNC INSTITUTIONAL REVIEW BOARD

Request for Change in Protocol

UNIVERSITY of NORTHERN COLORADO

Student Copy

Date of Original IRB Approval: 3/3/2008

Project Title: Preschoolers' Understanding of the Source of Knowledge: Are Peers Reliable Contributors of Knowledge?

Lead Investigator
Name: Kathryn A. Cooper, M.A.
Department: School of Psychological Sciences, Educational Psychology
Telephone: 303-949-3129
Email: nort6868@blue.unco.edu

Research Advisor (if applicable)
Name: Mark Alcorn, Ph.D.
Department: School of Psychological Sciences
Telephone: 970-351-2914
Email: mark.alcorn@unco.edu

On a separate page, describe and provide justification for the changes being proposed. Be concise and specific in describing methodological changes that affect the experience of participants and/or relate to the risks/benefits of participation. Explain why these changes are necessary.

√ Yes — No The proposed changes in protocol will necessitate changes in documents such as recruitment flyers, consent forms, debriefing forms, or other project-related documents.

√ Yes — No If yes, copies of the revised documents with changes highlighted are attached to this request.

CERTIFICATION OF LEAD INVESTIGATOR
I certify that information contained in this request is complete and accurate.

Kathryn A. Cooper — 5/20/2008
Signature of Lead Investigator — Date of Signature

CERTIFICATION OF RESEARCH ADVISOR (If Lead Investigator is a Student)
I certify that information contained in this request is complete and accurate.

Mark A. Al — 5/21/08
Signature of Research Advisor — Date of Signature

Approved by: Gary D. [signature] — 2 June 08
Chairperson, Institutional Review Board — Date

Date Request Received by SPARC: 5/21/08

SPARC/04/03

UNC INSTITUTIONAL REVIEW BOARD
Request for Change in Protocol

NORTHERN COLORADO

STUDENT'S COPY

Date of Original IRB Approval: 3/3/2008

Project Title: Preschoolers' Understanding of the Source of Knowledge: Are Peers Reliable Contributors of Knowledge?

Lead Investigator	Name:	Kathryn A. Cooper, M.A.
	Department:	School of Psychological Sciences, Educational Psychology
	Telephone:	303-949-3129
	Email:	Kathryn.cooper@unco.edu
Research Advisor (if applicable)	Name:	Teresa McDevitt, Ph.D.
	Department:	School of Psychological Sciences
	Telephone:	970-351-2482
	Email:	teresa.mcdevitt@unco.edu

On a separate page, describe and provide justification for the changes being proposed. Be concise and specific in describing methodological changes that affect the experience of participants and/or relate to the risks/benefits of participation. Explain why these changes are necessary.

√ — The proposed changes in protocol will necessitate changes in documents such as recruitment flyers, consent forms, debriefing forms, or other project-related documents.
Yes No

√ — If yes, copies of the revised documents with changes highlighted are attached to this request.
Yes No

CERTIFICATION OF LEAD INVESTIGATOR
I certify that information contained in this request is complete and accurate.

Kathryn A. Cooper 9/9/08
Signature of Lead Investigator Date of Signature

Words obscured on flyer

CERTIFICATION OF RESEARCH ADVISOR (If Lead Investigator is a Student)
I certify that information contained in this request is complete and accurate.

Teresa McDevitt 9/9/08
Signature of Research Advisor Date of Signature

Please note that Dr. Alcorn signed original form but we are co-advising Kathryn and he is out of town -- hence my signature.

Approved by: Gary D. Heise
Chairperson, Institutional Review Board Date

Date Request Received by SPARC: 9/9/08

SPARC/04/05

APPENDIX F

INFORMED CONSENT FORM

UNIVERSITY of NORTHERN COLORADO

Informed Consent for Participation in Research
University of Northern Colorado
Project Title: Young Children's Evaluations of Others' Knowledge

Researcher : Katie Cooper, MA, Psychological Sciences
Phone Numbers: (303) 949-3129
Research Advisors: Teresa McDevitt, Ph.D. & Mark Alcorn, Ph.D., Psychological Sciences
Phone Number: (970) 351-2482 & (970) 351-2914

I am conducting research on children's evaluations of others as they investigate objects and acquire knowledge about the objects. If you grant permission and if your child indicates to me a willingness to participate, we will go to a quiet area of the school near the classroom to complete a preschool task. The task will require a total of 15-25 minutes.

Initially, your child will be shown a laptop computer screen displaying two model peers each sitting at a table. The peers will be described as kids that are about their age but who go to another preschool. The peers, "played this game before and this is a video of how they did." Your child will then be presented with five containers that he or she will be required to investigate in order to answer questions about the contents of the containers. For example, your child will listen to headphones connected to a compact disc player and your child will be asked, what song is being played? After your child shares what he or she knows about the objects, your child will be asked to watch the video of how two other kids did. Your child will then be asked if each of the other kids was correct or incorrect.

Next your child will be shown a series of objects which can be worn to interfere with the learning process. For example, large oven mitts could prevent someone from feeling the weight or texture of an object and a sleeping mask could prevent the wearer from seeing the properties of an object such as its color. I will demonstrate the function of the various objects and will allow your child to also "try on" the objects. During this time your child will not be asked any questions but will simply watch and listen to me followed by an invitation to experience each of the wearable objects. The overall goal for this time is to allow your child to become comfortable with the materials and me.

Lastly, your child will be asked to watch the two model peers play a game while wearing some of the objects that were just shared. After your child watches each of the model peers investigate a set of everyday objects he or she will be asked about the objects. Your child will therefore need to consider which of the peers had the most appropriate access in order to acquire information about each of the objects.

I will write your child's responses to the questions on data sheets that will be kept private. Your child will be assigned a participant number and their name will not be included on any of the data sheets. The results from all of the participants will be analyzed and no names will be included in any reports.

I am interested in how your child evaluates another's knowledge. Children's understanding of how knowledge is acquired is still developing during the preschool years. There are times in which your child may not have direct access to an object and his or her knowledge about that object will therefore be based upon another's direct experience with the object. It is not fully clear how children think about how knowledge is acquired and whether another's acquired knowledge is accurate.

Your child will be reminded that for his/her participation, (s)he will receive a couple of treats throughout the session. The possible treats include Cheerios, Fruit Loops, M&Ms and raisins.

I do not envision any risks to your child beyond those that may occur while playing games at school. Your child will not be asked to participate during snack, lunch, or nap times. The games are fairly simple and the only feedback to your child will be positive (e.g., "You're playing very well." "You did just fine." etc.). This study is not designed to improve your child's understanding of others' beliefs or knowledge source but your child will likely enjoy the activities, the treats, and the positive attention received.

Please feel free to call me if you have any questions or concerns about this research and please retain one copy of this letter for your records.

Your participation in my research is greatly appreciated.

Sincerely,

Katie Cooper

Participation is voluntary. You may decide not to allow your child to participate in this study and if (s)he begins participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact the Sponsored Programs and Academic Research Center, Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1907

________________________________ ________________________________

Child's Full Name (please print) Child's Birth Date (month/day/year)

________________________________ ____________________

Parent/Guardian's Signature Date

________________________________ ____________________

Researcher's Signature Date

Please indicate below if there are any restrictions on what treats we may use with your child as if, for example, your child has a food allergy.

APPENDIX G

PARENT FLYER

HOW DO CHILDREN KNOW WHETHER OTHERS ARE GOOD SOURCES OF KNOWLEDGE?

PARENTS OF 4 & 5 YEAR OLD CHILDREN

Your child is invited to participate in a research study that will assess how children evaluate whether other children are good sources of information.

The study is designed as a preschool **game** and lasts for approximately **25 minutes**. The game will take place at school. The only feedback to your child will be **positive** and your child will also be offered **food treats** for his/her participation. Most children that participate find it to be fun and interesting!

Children undoubtedly learn a lot from each other but how do they determine whether others are good sources of knowledge? This study is designed to contribute to our overall understanding of how children evaluate various sources of knowledge. As we know more about this, instructional practices can be better designed for children to learn from each other.

In order for your child to participate, you will need to read and sign the attached parent/guardian consent form and answer a few questions about your child. All of that information including your child's responses will be kept **confidential**.
Please insert the
completed forms into the included envelope, seal it, and submit to the large manila envelope posted in the classroom.

THANK YOU VERY MUCH FOR YOUR CONSIDERATION!

UNIVERSITY of NORTHERN COLORADO

Please contact Katie Cooper if you have any questions k.cooper@mail.com or 303.949.3129.

APPENDIX H

PARENT QUESTIONNAIRE

UNIVERSITY *of* NORTHERN COLORADO

Parent Questionnaire

Please answer the following question about your child who will be participating in the study:

(1) What is your child's gender? MALE FEMALE

(2) What is your child's primary language? ______________________________

(3) Does your child have a major medical condition? YES NO

(4) If you answered yes to question 3, what is the condition? ___________________

____

(5) Does your child have a learning or developmental disability? YES NO

(6) If you answered yes to question 5, what is the disability?____________________

____

(7) When did your child first enter preschool? _______________ ____________
month year

Please insert the parent signature form and this questionnaire in the attached envelope and then seal the envelope.

Thank you for sharing information about your child. This information will be summarized across all participants to describe the children who participate in the study. The results of the questionnaire will be kept confidential.

APPENDIX I

PARTICIPANT DISTRIBUTION LIST

PARTICIPANT DISTRIBUTION LIST

		Gender		Four-year-olds												Five-year-olds												Condition			
	#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
7.7.08	1		■										■																		A
	2	■				■																								A	
7.10.08	3		■															■										A			
	4	■		■																									A		
	5		■									■																A			
7.14.08	6	■		■																								B			
	7	■															■												B		
	8	■		■																										B	
7.17.08	9		■																			■							A		
	10	■																■													B
	11		■																							■		C			
	12	■																									■		C		
	13		■										■																	C	
	14	■																				■									C
	15		■		■																							B			
	16		■							■																			B		
	17		■																								■			B	
	18		■	■																											B
7.22.08	19		■																						■						A
	20	■																						■						A	
	21		■													■													A		
	22		■											■														A			
	23		■						■																			C			
	24	■																							■				C		
	25	■				■																								C	

	#	Gender		Four-year-olds												Five-year-olds												Condition			
		M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
	26	■				■																									C
	27	■																	■									B			
	28		■									■																	B		
7.24.08	29		■												■															B	
	30	■					■																								B
	31	■			■																										B
	32	■									■																			B	
	33		■	■																									B		
7.31.08	34		■																■									B			
	35		■																							■		A			
8.5.08	36	■																									■		A		
	37	■																								■				A	
	38	■																			■										A
	39	■																				■						C			
	40	■																									■		C		
8.18.08	41	■						■																						C	
	42		■	■																											C
	43		■	■																								C			
	44	■																				■							C		
	45	■																■												C	
9.3.08	46	■							■																						C
	47		■							■																				A	
	48		■						■																						A
	49		■		■																										A
9.4.08	50	■				■																						B			

		Gender		Four-year-olds												Five-year-olds												Condition			
	#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
9.4.08	51		■	■																										C	
	52	■																									■	A			
	53	■														■														A	
9.22.08	54	■											■																B		
	55	■										■																			C
	56		■	■																									A		
	57		■										■																		B
9.26.08	58	■			■																									B	
	59	■															■												C		
	60		■													■												C			
	61		■						■																						B
	62		■										■																		C
10.3.08	63	■										■																A			
	64		■														■											C			
	65		■				■																						B		
	66	■											■																A		
	67		■											■														B			
10.8.08	68	■										■																		C	
	69		■	■																										A	
	70	■													■														C		
	71		■		■																										A
	72		■											■																B	
	73	■				■																								B	
	74	■												■																	A
	75	■						■																					C		

		Gender		Four-year-olds												Five-year-olds												Condition			
	#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
	76	■									■																				C
10.9.08	77	■																	■										B		
	78	■									■																		A		
	79	■								■																		C			
10.14.08	80		■									■																B			
	81	■					■																							A	
	82		■													■															B
10.16.08	83	■							■																					C	
	84	■															■											A			
	85	■				■																							B		
10.20.08	86		■								■																			B	
	87	■				■																									C
	88		■												■															C	
	89	■										■																		A	
	90		■													■															B
	91		■																				■					C			
	92	■																							■				C		
10.21.08	93	■																		■								A			
	94	■														■															A
	95	■																■										B			
	96	■							■																				A		
	97	■														■													C		
	98	■				■																									C
	99	■							■																				B		
	100		■																				■					B			

		Gender		Four-year-olds												Five-year-olds												Condition			
	#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
	101	■																							■					A	
	102	■																									■	C			
10.22.08	103		■												■													A			
	104		■				■																							C	
	105		■		■																								A		
	106		■	■																										B	
	107		■															■													B
	108	■																									■				A
10.23.08	109	■																									■		C		
	110	■																■										B			
	111	■																	■											C	
	112	■																									■		A		
	113		■																							■				B	
	114		■																			■									B
	115	■																						■				C			
10.24.08	116	■						■																							A
	117		■						■																			A			
	118		■				■																						B		
	119	■							■																					A	
10.27.08	120	■					■																								C
	121	■							■																			A			
	122		■											■																A	
11.5.08	123	■									■																	B			
	124		■								■																				B
	125	■							■																					C	

		Gender		Four-year-olds												Five-year-olds												Condition			
	#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
	126		■							■																		C			
	127	■													■														C		
	128		■									■																		B	
	129		■			■																							B		
11.10.08	130	■								■																			A		
	131		■									■																			A
	132		■														■														C
	133		■											■														C			
	134	■													■													A			
	135		■															■												C	
11.13.08	136		■										■																C		
	137		■													■															C
	138	■														■														B	
	139	■						■																				B			
	140		■								■																		A		
	141		■										■																B		
11.22.08	142		■																	■											A
1.14.09	143		■																						■					A	
	144	■															■														B
	145		■																■									A			
1.16.09	146	■														■												C			
	147	■																			■								B		
	148	■																■												C	
	149	■															■													B	
	150	■															■														C

	#	Gender		Four-year-olds												Five-year-olds												Condition			
		M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
	151		■													■													A		
1.22.09	152		■														■											B			
	153	■																		■									C		
	154	■																■												A	
	155		■															■													B
1.23.09	156		■															■													A
	157		■																■										B		
	158	■																■												B	
	159		■																		■									C	
	160	■																							■						C
1.28.09	161		■																	■									A		
	162		■																		■								B		
	163		■														■													A	
	164	■																							■			B			
1.29.09	165	■															■														A
	166		■														■														B
	167		■													■													C		
	168	■																			■							A			
	169	■																			■							C			
1.30.09	170	■																			■									B	
3.1.09	171		■																■										B		
3.6.09	172		■																	■										C	
	173		■																		■								A		
	174		■																			■								B	
	175		■																			■							B		

	Gender		Four-year-olds												Five-year-olds												Condition			
#	M	F	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	1	2	3	4
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APPENDIX J

SITE CURRICULUM DESCRIPTIONS

PRESCHOOL SITE CURRICULUM DESCRIPTIONS

Information about the curriculum adopted by seven of the preschools participating in the study; excerpts were taken from brochures and websites:

- The staff at the Center thinks of the children as "our little babies" and like keeping the children safe, comfortable, and fed. The teachers enjoy expanding on the children's interests to keep them fulfilled.
- [The] Center is dedicated to the spiritual, emotional, physical, social, and intellectual development of children through innovative education. We strive to nurture each child's unique qualities and potential by implementing developmentally appropriate activities in an environment of Christian love and values. We believe a child's understanding grows through hands-on play and exploration.
- [The] Preschool staff applaud and support all the love and dedication in the good job you do in parenting your children. We would like to add to your efforts and work together to ensure the growth and development necessary for kind and happy little people, as well as a good start in the formal school experience. [The] preschool provides planned activities for children to play and learn together. Christian love and values are stressed while working with children to find their place in the classroom setting.
- The purpose of [the] Learning Center is to provide the highest possible type of care and learning in a distinctly Christian atmosphere with consistent, consecrated teachers. We believe that every child has a great learning potential. We seek to

foster this potential to the fullest extent at the child's own rate of learning. At the same time, we believe that each child needs a great amount of tenderness, kindness, and affection. We strive to provide these in an atmosphere and attitude of love.

- The philosophy of [the] Preschool can be summed up by saying we PLAY TO LEARN. Thus, you will not see systematic work come home involving academic skills. For example, even if we are working on number sense, letters, writing, etc., your child will not bring home many worksheets, math work, or reading work. What you will see is your children daily engaged in play time, crafts, books, songs, games, experiments, and other activities that encourage them to make friends, explore the world around them, think for themselves, problem solve, and understand the relationships that numbers and letters have with their everyday life.
- The preschool is developmentally appropriate- both instruction and play are planned with developmental goals in mind. Preschool is a learning experience and provides challenges and stimulation to promote social and intellectual growth in a loving atmosphere with a Christian education emphasis. The curriculum provides a variety of enjoyable, creative learning activities such as art, music, literature, science, cooking, and free play.
- [The] Preschool exists to promote the social, physical, academic and spiritual development of individual preschool children ages 3-6 in a warm, loving Christian atmosphere. Daily activities include: Bible Verse/Story, Prayer, Art & Story Time, Music & Fingerplays, Science & Nature, Math & Problem Solving, Large & Small Motor Development.

Missing site descriptions include sites with similar philosophies to programs described above.

APPENDIX K

RESULTS FROM THE MANOVA FOR RESEARCH QUESTION ONE

RESULTS FROM THE MANOVA FOR RESEARCH QUESTION ONE

A 2 x 2 x 4 (gender x age x condition) MANOVA was run to assess for differences on each of the two phase scores. There were no significant main effects of gender for the total score on the Model Competency Evaluation phase ($F(1, 160) = 3.60$, $p = 0.06$) and total score on the Testing phase ($F(1, 160) = 2.32$, $p = 0.13$). As predicted, there was no significant effect of age on total scores on the Model Competency Evaluation phase ($F(1, 160) = 4.04$, $p = 0.05$). There was a significant difference between the 4- and 5-year-olds' total score on the Testing phase ($F(1, 160) = 27.57$, $p < 0.01$). As predicted, there were no significant differences in the total scores on the Model Competency Evaluation phase among the four different conditions ($F(3, 160) = 1.25$, $p = 0.30$). However, as predicted, there were significant differences in total scores on the Testing phase among the four conditions ($F(3, 160) = 6.18$, $p < 0.01$). There was no interaction between age and condition for the total scores on the Testing phase ($F(3, 160) = 0.45$, $p = 0.72$).