Toddlers' Reasoning about the Origins of Human Actions, Emotions, and Knowledge

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ABSTRACT

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Considerable research effort has been devoted to discovering and mapping out children's understanding of mental phenomena. Developmental psychologists have assessed children's ability to attribute mental states as well as their tendency to explain and predict human actions and emotions in terms of pre-existing mental states. Based on empirical findings obtained to date, it is believed that children come to understand human desires before they acquire a similar understanding of beliefs. In addition, it has been suggested that most children under the age of 3 years operate without any conception of belief (Wellman, 1993; Wellman & Woolley, 1990).

The present study which consisted of three experiments aimed to test young children's understanding of beliefs and desires, with an emphasis on how these states relate to a person's actions, emotions, and perceptual experience. Experiment 1 examined 18- to 30 month-old infants' understanding of the link between seeing and knowing, and their understanding of the link between surprised reactions and belief violations. Experiments 2 and 3 were created to assess 18- to 30-month-old children's understanding that desires guide actions and the knowledge that happy and sad reactions depend on the outcome of a person's pre-existing desires. In order to assess knowledge of these relationships, toddlers were administered a modified version of the preferential looking task that included videotaped stories involving actors and objects. The results of this series of experiments suggested that children as young as 18 months are "desire-psychologists" in the sense that they are able to relate another person's actions and emotional responses to that person's pre-existing desires. In contrast, children of that age showed no recognition that surprised reactions are associated with violations in a person's knowledge state, and no understanding of the link between seeing and knowing. Because of children's unanticipated bias for looking at the surprised expression, it is not possible to conclude presently whether children under 3 operate without a conception of beliefs.

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CHAPTER ONE: INTRODUCTION

One of the most active research areas in developmental psychology is the study of children's understanding of the mind, an area often referred to as children's "theory of mind." The expression theory of mind actually reflects a prominent theoretical position which holds that children's successive conceptions of the mind during development have much in common with scientific theories (e.g., Gopnik & Meltzoff, 1997; Gopnik & Wellman, 1994; Wellman, 1990). However, it is also used in a more generic sense to refer to the understanding of mental experiences, and the ability to explain and predict human action in terms of underlying mental states. Investigation into young children's understanding of the mental world began in the late 1920's (Piaget, 1929), although the bulk of research in this area has been undertaken only in the last 15 years, gaining impetus from similar work involving nonhuman primates (e.g., Premack & Woodruff, 1978). In general, more recent research has revealed a fairly sophisticated level of thinking about the mind in preschool-aged children. This conflicts with earlier work which suggested that children were largely ignorant of the mind until the age of 6 or 7 years (see, for example, Piaget, 1929).

Two areas of major interest within the theory of mind literature are 1) the nature of children's understanding of the mind at different developmental stages and, 2) the mechanisms by which children's conceptions of the mind change. The present study focused on the first of these questions, but has relevance to the second question as well. Specific goals were to further our understanding of mental state conceptions in 18- to 30-month-old children, and to test some hypotheses associated with a leading account of developmental change in children's conceptions of the mind, referred to as the Theory theory (Bartsch & Wellman, 1995; Wellman, 1993).

Early Understanding of the Mind: Definition of Key Terms

Before describing the present study, a few important terms will be reviewed, and some theories of developmental change in children's conception of the mind will be highlighted. In addition, a review of major empirical findings concerning young children's understanding of the mind is presented. To date, the majority of research on children's understanding of the mind has been conducted with preschool-aged children. More recently a number of investigators have, through innovative methodological approaches, attempted to test infants' and toddlers' understanding of the mind as well.

In the theory of mind literature, a common practice is to distinguish between two classes of mental states, referred to as "beliefs" and "desires" (e.g., Harris, 1996; Wellman, 1993; Wellman & Banerjee, 1991). When making this distinction, these terms are to be understood in a broad sense. Beliefs include a variety of states such as knowledge, convictions, and expectations. Similarly, desires denote many attitudes including wants, wishes, preferences, goals, and hopes. There are several reasons for considering beliefs and desires separately. One has to do with the different origins of these two classes of mental states. Whereas beliefs often derive from perceptual experience, desires tend to originate with physiological states and basic emotions (Moses, Coon & Wusinich, in press; Wellman, 1991). These two classes of states also differ in terms of what Searle (1983) calls the "direction of fit" between mind and world. Whereas people typically revise their beliefs so that they reflect the world as it really is, they normally try to alter aspects of the world to bring them in line with their desires. The distinction between beliefs and desires also has an empirical basis, which is that understanding of desires appears to precede a similar understanding of beliefs developmentally (e.g., Bartsch & Wellman, 1995; Wellman & Woolley, 1990). For example, desire terms like want and wish enter the child's productive vocabulary before belief terms like think and know (Bartsch & Wellman, 1995). The reasons for this developmental sequence has been a topic of some debate and will be addressed at a later point (e.g., Bartsch & Wellman, 1995; Harris, 1996).

A second convention relating to children's understanding of the mind is to differentiate between the "ontological" and the "causal" aspects of mind (Wellman, 1993, 1990). The ontological aspect refers to the understanding that mental entities such as beliefs and desires are distinct from and have different properties than physical objects and observable actions. For example, understanding of the ontological aspect of mind includes the recognition that mental entities, unlike physical objects, are subjective and transitory, and cannot be seen or touched. While not a focus of the current discussion, there are several lines of evidence to suggest that preschool-aged children recognize the ontological aspect of mind (Estes, Wellman, & Woolley, 1989; Harris, Brown, Marriot, Whithall, & Harmer, 1991; Wellman & Estes, 1986). For example, 3-year-olds understand that an imagined dog cannot be seen, touched or petted, but that a real dog can. In addition, they seem to recognize the subjectivity of thoughts and desires (Estes et al., 1989; Flavell, Flavell, Green & Moses, 1990). With regard to younger children, there is evidence that 18-month-olds understand the subjectivity of food preferences, whereas 14-month-olds egocentrically attribute their own food preferences to others (Repacholi & Gopnik, 1997). This suggests that when they are very young, infants may not appreciate the subjectivity of mental states, but rather think of themselves and others as sharing the same psychological states (Hobson, 1993; Trevarthen, 1979). Moreover, there is some doubt as to whether infants actually distinguish between mental and physical states, although they do seem to separate people and objects (Gopnik & Meltzoff, 1997).

The causal aspect of mind, which is the focus of this thesis, concerns the understanding of how beliefs and desires function within the context of the explanatory framework that people use to make sense out of others' behavior, often referred to as a "belief-desire psychology" or a folk psychology. Understanding of the causal aspect of mind encompasses knowledge of several relationships within this framework, including what have been termed mind-world linkages and mind-mind linkages (Searle, 1983). Mind-world connections refer to the fact that we often interpret people's observable actions in the world as being caused by pre-existing mental states. For instance, I might explain another person's reaching for a cookie jar by attributing to that person a desire for a cookie and the belief that there are cookies in the jar. Mind-world linkages may operate in the opposite direction as well. For example, adults construe some mental states as being grounded in physiological states (e.g., desires) and others as being caused through perceptual contact with the world (e.g., knowledge). Mind-mind linkages refer to a different set of relationships, namely the relationships between mental states (desires or beliefs) and emotional reactions which are considered to depend on those mental states. For example, we often explain happy reactions in others by inferring that a person's prior desire was satisfied.

To date, research on children's understanding of the causal aspect of mind has explored children's understanding of both mind-mind and mind-world connections. Three components of the causal aspect of mind that have received considerable research attention are 1) understanding of the role of beliefs and desires in human action, 2) understanding that emotional reactions may depend on a person's preexisting beliefs or desires, and 3) understanding of perception as a knowledge acquisition device.

Theoretical Accounts of Children's Understanding of the Mind

A number of theories have been proposed to explain developmental changes in children's understanding of the mind (Carruthers & Smith, 1996; Harris, 1991; Leslie, 1987). One of the most influential of these is the "Theory theory" (Bartsch & Wellman, 1995; Gopnik & Wellman, 1994; Wellman, 1990, 1993). According to this account, children construct a succession of naive theories of the mind which gradually approximate the adult's everyday understanding of the mind, which is also viewed as an implicit naive theory. The central idea behind the Theory theory is that children's conceptions of the mind share important similarities with scientific "framework theories," also referred to as paradigms (e.g., Gopnik & Wellman, 1994). Children's knowledge of the mind is considered theoretical because of its abstractness, coherence, and extensive explanatory and predictive power. In addition, changes in children's conceptions of mind are proposed to involve processes similar to those observed in scientific paradigm shifts (Kuhn, 1962), including denial of initial counter evidence, formation of ad hoc auxiliary hypotheses to deal with counter evidence, and the eventual formulation of alternative theories.

While the Theory theory has gained widespread acceptance, alternative explanations of developmental change exist. Simulation Theory (Harris, 1991) holds that a child's psychological knowledge is based on his or her first person psychological experience. Through introspection, the child becomes aware of his own mental states (e.g., desires, beliefs and feelings) and can then use this awareness to understand similar states in others. Another interesting proposal is that children's psychological knowledge may be organized in terms of scripts, or rough empirical generalizations, which allow for simple predictions, but lack theories' explanatory power (Astington & Gopnik, 1991a). While other accounts exist (e.g., Leslie, 1987, 1988), it is beyond the scope of this paper to review all of them here and to evaluate their respective merits. Instead, the current study will endeavor to test two major hypotheses primarily associated with the Theory theory which are that the understanding of desires precedes the understanding of beliefs, and that the 2-year-old child operates without a conception of belief (Wellman, 1993; Wellman & Woolley, 1990).

Developmental Sequence Posited by the Theory Theory

Over the past few years, proponents of the Theory theory have begun to characterize the sequence of development in children's understanding of the mind, and to flesh out what the successive theories are like (e.g., Bartsch & Wellman, 1995; Gopnik & Meltzoff, 1997). The following is a brief overview of the proposed sequence. Although successive theories are associated with particular ages, more emphasis is to be placed on the order of acquisition, since some variation is expected in the age of acquisition of specific theories.

In general, the Theory theory posits the acquisition of increasingly sophisticated theories that differ in terms of their central explanatory constructs. The purpose of these theories is to explain human actions and emotional reactions. The developmental end state in this succession of theories is a relatively complex explanatory framework referred to as a "belief-desire psychology" (Wellman, 1990). As suggested by the name, the central constructs in this mature explanatory system are beliefs and desires. While both are considered necessary to fully explain a person's actions, beliefs are of primary importance because people behave not in a manner that necessarily will achieve their desires, but in a way they believe will achieve those desires.

So far, theory theorists have mainly focused on the period of development extending from 2 to 5 years of age, with less consideration being given to how younger infants might construe the mind. However, it has been hypothesized that infants come equipped with innate mechanisms that prepare them to acquire a belief-desire psychology. For example, Wellman (1993) proposed that two precursors, mechanisms that select social objects for special processing and the infant's understanding of animate causation, may form the foundation for later understanding of the ontological and the causal aspects of mind respectively. Another hypothesis is that infants possess an innate appreciation of the similarity between themselves and other people, which helps to explain their early imitative abilities and serves as a foundation for later conceptions of the mind (Gopnik & Meltzoff, 1997).

While some have proposed that infants construe other people in a mentalistic fashion from birth (Premack, 1990; Trevarthen, 1979), a more common view is that infants come to recognize others as psychological agents after a series of steps (Poulin-Dubois, in press; Tomasello, 1995). Moreover, it is proposed that infants come to appreciate certain mental states in advance of others. Wellman, for instance, has suggested that by 18 to 24 months, and possibly earlier, infants acquire an "intentional" understanding of desires, perception, and emotion (Wellman, 1993), while lacking a similar notion of beliefs. An intentional understanding implies recognition of both the experiential and the referential nature of a mental state, allowing the infant to construe others as experiencing internal states that are about, or directed towards, particular objects, actions, or states of affairs. According to Wellman and Woolley (1990), "3 years is just about the earliest age at which children understand belief and can thus participate in belief-desire reasoning." Thus, while individual differences are expected, most children are considered to operate without a concept of belief until the months just prior to their third birthday. For this reason, the 2-year-old's theory of mind has been named a "simple desire psychology" or a "desire-perception" psychology, emphasizing the assumption that 2-year-olds construe people in terms of a limited set of mental states that does not include beliefs.

Unlike 2-year-olds, who are purported to lack a concept of beliefs, 3-year-olds are proposed to have an understanding of belief, which though present, serves only a minor role in their reasoning about the actions of other people (Wellman, 1993). Thus 3-year-olds, like younger children, are considered to be desire psychologists primarily when it comes to explaining human actions. The causal-explanatory framework characteristic of 3-year-olds has been called a desire-belief psychology (Bartsch & Wellman, 1995), so as to underline the continuing primacy of desires in children's explanations of human action.

Finally, around 4 years of age, children are proposed to acquire a new theory of mind, a "belief-desire psychology." This new psychology is simpler than the adults' theory of mind in that it lacks certain elements, such as the construct of personality traits, that inform adults' explanations of the actions of other people (Wellman, 1990). Nonetheless, this expanded psychology shares many important features with an adult's theory of mind, and assigns an important explanatory role to beliefs. Having developed this theory, children regularly attribute beliefs in their efforts to make sense of other people's actions.

In summary, many researchers now agree that children hold a succession of psychological theories, which originate from certain innate precursors and culminate in a mature belief-desire psychology. Like framework theories in science, children's naive theories identify a domain (observable actions and emotions) and make an ontological distinction (between mental and physical entities). Moreover, children's theories are characterized by constructs (desires and beliefs) which are used to predict and explain observable actions and emotional reactions in other people.

Young Children's Reasoning about Beliefs

The Role of Beliefs in Human Action

As mentioned earlier, theory of mind researchers have investigated several specific areas of causal understanding in young children, one of which is the understanding that mental states guide human actions. So far, most studies have focused on the competencies of preschool-aged children, and have employed verbal tasks involving human actors, or dolls that are presented as real. For example, in tasks assessing understanding of the role of beliefs in human action, preschoolers are typically asked to predict an actor's future actions based on information about what the actor believes. Alternatively, children are sometimes asked to explain completed actions, to determine whether or not spontaneous reference to beliefs is made.

The understanding that beliefs frame actions has been assessed mainly using "false belief tasks" (Hogrefe, Wimmer, & Perner, 1986; Wimmer & Perner, 1983). In order to solve false belief tasks, a child needs to be able to attribute a false belief and to recognize that people act in accordance with their beliefs, even when they happen to be wrong. The ability to attribute a false belief to another person is considered important, because it implies recognition of the fact that beliefs are not just copies of reality, but rather representations of reality that may be incorrect. In one well known standard false belief task, sometimes referred to as an "unexpected transfer task," the subject is told about a boy who erroneously believes that his chocolate is in a green cupboard where he last left it, not realizing that his mother had moved the chocolate to a different location (blue cupboard) while he was out (Wimmer & Perner, 1983). In the critical test question, children are asked to predict where the boy will search for the chocolate upon his return.

There is now ample evidence that 3-year-olds fail standard false belief tasks whereas children 4 years and older pass without difficulty (e.g., Hogrefe et al., 1986; Perner, Leekam, & Wimmer, 1987). Typically, 3-year-olds respond to the unexpected transfer task by predicting that the protagonist will search for the transferred object in its actual location, rather than correctly basing their predictions on the protagonist's false belief. Moreover, 3-year-olds appear to have difficulty understanding even their own false beliefs (Gopnik & Astington, 1988). For example, on a different task, 3-year-olds were shown a Smarties box and asked to guess its contents. Prior to seeing the actual contents, all children said they thought that the box contained candies. When shown the true contents of the box (pencils), 3-year-olds were unable to recall their previous false belief even when prompted (Wimmer & Hartl, 1991).

Different explanations have been put forward to account for 3-year-olds' difficulty with false beliefs. One proposal is that they are not able to conceive of a false belief because they lack the necessary understanding of mental representation (and misrepresentation), which does not emerge until 4 years of age (e.g., Perner, 1991). Another explanation is that 3-year-olds can attribute false beliefs, but lack the understanding that people's actions are "always, necessarily framed by their beliefs" (Wellman, 1993). A third view holds that the portrayal of 3-year-olds as being ignorant of false beliefs is incorrect, and has resulted from too exclusive a reliance on standard false belief tasks which fail to provide children with a motive or personal stake in understanding the mental states of others (Hala & Chandler, 1996).

Consistent with the last view, 3-year-olds successfully answered questions about another person's false belief and made accurate action predictions on the basis of those beliefs when administered a deception task where a motive/incentive was given for considering the other person's mental state (Hala & Chandler, 1994). In addition, 3-year-olds have demonstrated an understanding of false beliefs in tasks where they are required to explain completed actions, rather than predict future actions. For example, in a study by Bartsch and Wellman (1989), children were told about a story character, Jane, who was searching for her dog under the piano, even though her dog was really on the porch. In this context, 52% of 3-year-olds provided at least one spontaneous belief explanation, in which they attributed a false belief in order to explain anomalous actions by the story character. Success was even greater in the prompted explanation condition, where 74% of 3-year-olds provided at least one belief explanation.

So far, very few studies have assessed the understanding that beliefs guide actions in children under the age of 3 years. A notable exception is Clements and Perner (1994) who administered a modified version of the unexpected-transfer task to older 2-year-olds. In this task, which was presented by means of a story board with pictures, children were told about a mouse called Sam, who stores a piece of cheese in one location before going to sleep. While he is sleeping, another mouse moves the cheese to a new location. Prior to asking the explicit action prediction question used in standard tasks, the experimenter prompted the child by saying "I wonder where Sam is going to look?" and the child's looking reactions were monitored. The results revealed an interesting discrepancy between 2-year-olds' nonverbal and verbal responses. When anticipatory looking was used as an index of comprehension, children showed an implicit understanding that beliefs frame actions. That is, they responded to the prompt by looking at the box where Sam mistakenly believed the cheese to be, in apparent anticipation of his next action. In contrast, performance on the explicit verbal prediction task was poor. This discrepancy was explained in terms of a distinction between representing a fact and making a judgment about that fact.

In summary, some implicit understanding of the role that beliefs play in guiding human actions appears to be present in children as young as 2 years, as indexed by children's nonverbal behavior on a modified false belief task. However, children this age do not typically appeal to beliefs when explaining actions in their everyday conversations (Bartsch & Wellman, 1995) and are unable to succeed on standard action-prediction tasks. By 3 years, children begin to generate belief-based action explanations in conversation, and are able to invoke false beliefs in explaining actions that are already completed. Despite these early competencies, it is clear that 2- and 3-year-olds have a weaker and less generalized understanding the role of beliefs in human action than do 4-year-olds, as evidenced by their failure on standard false belief tasks requiring action predictions.

The Role of Beliefs in Emotional Reactions

Theory of mind researchers who have assessed young children's understanding of emotions have not typically addressed the question of what an emotion is. No doubt this relates to the lack of agreement among emotion theorists themselves concerning the definition of the construct of emotion (Shaver, Schwartz, Kirson, & O'Connor, 1987). Despite this difficulty, most emotion theorists do posit a set number of basic emotions (e.g., joy, sadness, anger, fear, surprise, and disgust), although there is some variability in terms of which emotions are viewed as basic (e.g., Ekman, 1984; Izard, 1977). In addition to having associated facial expressions and behaviors, at least some basic emotions appear to have cognitive antecedents or causes and it is knowledge of these antecedents that has been of the most interest to theory of mind researchers.

As mentioned earlier, understanding of the causal aspect of mind encompasses knowledge of the connections existing between mental states. A prime example of this are emotional reactions based on a person's prior mental states. Theory of mind researchers have looked at children's understanding of two classes of mental state-based emotions, referred to as "desire-dependent emotions" and "belief-dependent emotions" (Wellman & Banerjee, 1991). Desire-dependent emotions, such as happiness and sadness are states that occur in response to the fulfillment or thwarting of a desire. Belief-dependent emotions, such as surprise and curiosity, are considered to result from the confirmation or violation of a person's previous belief, or from the presence or absence of a knowledge state. Understanding of desire- and belief-dependent emotions is a potentially difficult task, since one is required to consider three separate pieces of information: an actor's mental state, outcome information, and the actor's emotional reaction.

One common way in which children's understanding of mental-state based emotional reactions has been investigated is via emotion-prediction tasks, in which children are asked to predict another person's emotional reaction to a specific outcome based on information about that person's belief (or desire). Another approach has been to ask children to explain a story character's emotional reactions in specific situations in order to evaluate whether mental state explanations are provided. Concerning children's understanding of belief-dependent emotions, research efforts to date have focused primarily on the understanding of surprised reactions. While some studies purport to show a belief-based conception of surprised reactions in 3-year-olds, other research suggests that such a conception is not achieved until the age of 4 years or later.

Hadwin and Perner (1991) investigated children's understanding of desire- and belief-based emotions using an emotion-prediction task. In their task, children were told about a character who desired or believed something (e.g., that a particular child had his ball), and were then given outcome information that was either consistent or inconsistent with that desire or belief. Whereas a large majority of 3-year-olds (81.25%) understood how desires impact on emotions, very few of them (12.5%) appeared to understand the conditions necessary to elicit surprise. Even 4-year-olds were largely unsuccessful in predicting that the protagonist would be surprised when his expectation differed from reality. Based on these and similar findings, Hadwin and Perner concluded that young children have a general problem understanding that some emotions are causally related to beliefs.

MacLaren and Olson (1993) studied children's understanding of surprised reactions in a slightly different way, by having them judge the kinds of stimuli that were surprising to themselves, and that would surprise another person. Subjects aged 3 to 8 years were presented stimuli that were either expected (e.g. toothpaste box with toothpaste inside) or unexpected (e.g., toothpaste box with candy or rocks inside). The unexpected stimuli included both desirable objects (treats) and undesirable objects (tricks), so that the influence of desirability on children's judgments could be assessed. While 3-year-olds accurately stated which contents were surprising to themselves, they had difficulty judging the kinds of stimuli that would be surprising to another person. Judgments were particularly poor on questions involving undesirable unexpected contents (tricks), where the percentage of children passing the surprise questions was 5% and 38% for 3- and 4-year-olds, respectively. Based on these findings, it was suggested that young children initially misconstrue surprise as a state that follows the presentation of objects with desirable properties, as opposed to a state brought on by unexpected events.

While the forgoing studies suggest that 3-year-olds do not understand that surprised reactions are mediated by beliefs, greater competence has been shown in studies using an emotion-explanation method. For example, in a study by Wellman and Banerjee (1991), 3- and 4-year-old subjects were told about a character who felt happy, sad, surprised, or curious, and were then asked an open-ended question about why the character felt that way (e.g., "Jeff visited his grandma and when he got to her house he saw that it was purple. He was very surprised. Why was Jeff so surprised?"). Of interest was whether children's explanations for belief-based emotions (surprised and curious) would differ from their explanations for desire-based emotions (happy and sad). Analyses of children's explanations suggested that 3-year-olds do recognize the link between beliefs and emotions, although their performance was inferior to that of the 4-year-old subjects. Fifty-two percent of 3-year-olds spontaneously mentioned a relevant belief (e.g., Jeff didn't think the house would be purple) as the explanation for the character's emotional reaction on at least one of the four surprised and curious stories, and 83% did so on a follow-up question in which they were asked to say what the character was thinking.

To date, no study has assessed understanding of belief-dependent emotions in children under 3 years of age. However, there is evidence that infants possess considerable knowledge of emotions, which might at least serve as a foundation for mental-state conceptions of various emotions. In the following section some findings on infants' emotional understanding will be reviewed, with an emphasis being placed on understanding of surprised reactions and expressions. Infant researchers have studied several aspects of emotional understanding including the ability to discriminate and categorize facial expressions associated with particular emotions, production and comprehension of the terms used to describe various emotions (e.g., happy, surprised), the ability to match emotion labels with facial expressions, knowledge of typical emotion-eliciting situations, the understanding that emotional states are subjective, etc. In addition, they have investigated naturally occurring behaviors which seem to reflect emotional knowledge, such as social referencing, teasing behaviors, and the empathic or comforting behaviors sometimes seen in toddlers. As these naturally occurring behaviors seem more relevant to the understanding of desire-dependent emotions, they will be discussed at a later point.

One early and important development in young children's emotional understanding is the ability to differentiate and recognize different emotional expressions. This has been tested in discrimination studies, which assess the ability to distinguish different expressions posed by the same model, and in categorization studies which assess the ability to recognize an expression (e.g., happy) over changes on some other dimension, such as the intensity of the expression or the model posing the expression. Though infants under 4 months seem able to discriminate certain expressions on the basis of isolated features or sets of features, they are considered to lack the visual skills needed to recognize facial expressions per se (Nelson, 1987). In contrast, between 4 and 7 months infants become able to categorize some expressions.

Another source of information concerning very young children's understanding of surprised reactions are studies assessing the ability to match various emotion labels to the appropriate facial expression. In general, these studies find that children as young as 2 years are able to associate surprised expressions with the label surprise. Michalson and Lewis (1985) assessed children's comprehension of emotion labels by presenting them with an emotion word (e.g., sad, angry, or surprised) and asking them to point to the correct face which was embedded in an array of four photographed faces. In this task, 60% of 2-year-olds correctly pointed to the surprised expression, despite the fact that no child this age generated the label surprise on production task in which they were asked to name different facial expressions. In a study by Smiley and Huttenlocher (1989), pairs of dynamic videotaped expressions (happy, sad, mad, surprised, and scared) were presented and subjects had to point to the face that matched the label provided. Using a strict criterion for task success (recognition of an emotion when paired with all other emotions), 53% of 2 1/2-year-olds showed comprehension of the surprised label.

Early understanding of surprised reactions was recently investigated through an examination of young children's natural language productions (Bartsch & Estes, 1997). Using longitudinal transcripts from 10 English-speaking children, Bartsch and Estes assessed uses of the word surprise from ages 2 to 5 years. Uses were coded along three dimensions: whether the term was used to indicate a psychological reaction or an object, whether it was used in the context of an unexpected or an expected event, and whether it marked a positive, neutral, or negative event. Consistent with previous findings (Bretherton & Beeghly, 1982), use of the word surprise was infrequent among children in this age range. In addition, surprise was rarely used as a psychological term or in the context of unexpected events before the age of four, and 2-year-olds never used the term in these ways. Instead, young children initially used the word surprise to refer to gifts, and only later to refer to a psychological reaction. Another finding was that most usages occurred in the context of positive events. Thus, there was no evidence of genuine understanding of surprised reactions in 2- or 3-year-old children. However, as the authors themselves note, it is possible that children understand surprised reactions, but do not talk about them using the term "surprise." This interpretation gains support from the finding that young children's comprehension of emotion labels exceeds their ability to produce these labels in an experimental situation (Michalson & Lewis, 1985).

Another aspect of emotional understanding that has been assessed in young children is knowledge of the kinds of situations that typically elicit various emotions (Barden et al., 1980; Borke, 1971; Harris, 1987; Huttenlocher & Smiley, 1989; Michalson & Lewis, 1985; Trabasso & Stein, 1981). This is of particular interest here, since it relates to children's understanding of how emotions are caused. In Michalson and Lewis' study, 2- to 5-year-old children were told stories about a girl involved in situations expected to elicit specific emotional responses, and were then asked to point to the emotional expression (embedded in a set of 4 expressions) that the girl would display in that situation. When asked how the girl would react to the unexpected situation (she saw her mother with pink hair), 40% of 2-year-olds correctly pointed to the surprised face, suggesting a beginning awareness of the kinds of events that elicit surprised reactions. In a different study conducted by Huttenlocher and Smiley (1989), subjects were presented with an emotion label (e.g., surprised, happy, and scared) and asked to point to one of two videotaped situations that might evoke that emotion. The surprising situations involved sudden appearances or unusual events (a birthday cake appears at the top of dark stairs, a tower rebuilds itself, a balloon is discovered in the refrigerator). In the context of this task, only 13% of 2-year-olds and 47% of young 3-year-olds correctly identified the surprising situation in response to the surprise label, suggesting an increase in children's understanding of the causal determinants of surprised reactions between 2 and 3 years. Although these findings suggest only a weak understanding of surprising situations at 2 years, this may have to do with unreasonable task demands.

While Michalson and Lewis' study suggested an early awareness of the kinds of situations that typically elicit surprised reaction, they do not reveal whether children appreciate the mediating effect of mental states on emotions. For instance, children may think that situations and events that they themselves find surprising (e.g., a woman with pink hair) will elicit similar emotions in other people, without appreciating that the other person's own expectations have been violated. In contrast, adults recognize that a person's emotional reactions are mediated by what that person wants or believes.

In summary, no previous study has assessed understanding of belief-dependent emotions in children under 3 years of age. The youngest age at which a mental-state conception of surprise has been found is at 3 years in the context of an emotion-explanation task (e.g., Wellman & Banerjee, 1991). In contrast, 3-year-olds perform poorly when required to predict surprised reactions on the basis of belief information, and on tasks involving emotionally-charged outcomes, where they tend not to appreciate that undesirable unexpected outcomes can sometimes be surprising. While understanding of belief-based emotions has not been tested in infancy, there is evidence that 2-year-olds recognize surprised facial expressions and have some ability to link surprised facial expressions to unexpected situations, suggesting some early awareness that surprise is associated with unusual or unexpected situations and events. However, these findings require replication. In addition, it is not known whether toddlers and infants appreciate the mediating effect of a person's beliefs and expectations on his or her emotional state.

Understanding the Perception-Knowledge Relationship

A different component of the causal aspect of mind concerns the understanding that beliefs, and specifically knowledge states, may be acquired through sensory experience. In particular, many studies have assessed children's understanding of the causal relationship between seeing and knowing, referred to here as the perception-knowledge relationship. According to Povinelli and Eddy (1996), an important distinction is to be made between a simple understanding of visual perception as attention and the more advanced understanding that visual perception may function as a knowledge acquisition device. The former implies the ability to conceive of another person as having a subjective experience about some currently present event or object in the world. In contrast, when children acquire an understanding of the perception-knowledge relationship, they become able to attribute knowledge states on the basis of the extent of visual contact, even after visual contact is broken (Povinelli & Eddy, 1996). That is, they recognize that the viewer experiences an event not only in the moment of perceiving it, but is left with a lasting mental impression that places him or her in a different epistemological position than someone who has not seen the event.

While many studies have evaluated understanding of the perception-knowledge relationship in preschool-aged children, a consensus has not been reached on the timing of this acquisition. Whereas some believe that the understanding of the perception-knowledge relationship is not in place until 4 years (e.g., Povinelli & Eddy, 1996; Wimmer, Hogrefe, & Perner, 1988), others attribute this understanding to children 3 years or younger (e.g., Pillow, 1989; Pillow & Brownell, 1991; Pratt & Bryant, 1990). In order to assess children's understanding of this relationship, a major approach has been to present them with two actors, one of whom is given access to an object via a specific sensory modality (e.g., vision, tactile experience, etc.), and another who is not. Children are then asked to make knowledge assessments, that is, to judge which of the two actors knows the identity or qualities of the object in question.

Wimmer et al. (1988) conducted a series of three experiments in which 3- to 5-year-old subjects were shown (or told about) the contents of a closed box, while another accompanying child was not given this information, and vice versa. Subjects were then asked to say whether they (and the other child) knew the contents of the box. While 3-year-olds accurately judged their own knowledge, they were not able to accurately infer the other child's knowledge state, even though they remembered whether or not the other child had had perceptual access to the contents of the box. In addition, they could not explain how they themselves sometimes knew the contents of the box. Based on these findings, the authors concluded that 3-year-olds are ignorant about the causal connection between perceptual access to information and resulting knowledge. Furthermore, they suggested that children's self-judgments were based on having knowledge, as opposed to being based on an understanding of how that knowledge was generated. Two other studies yielded similar results (Gopnik & Graf, 1988; Povinelli & DeBlois, 1992).

In contrast to these negative findings, some studies have confirmed understanding of the link between sensory experience and knowledge in 3-year-olds. Pillow (1989) asked 3- and 4-year-olds subjects to judge whether they or a puppet viewer knew the color of the hidden dinosaur, when only one of them was given visual access to the dinosaur. In the context of this task, 3-year-olds were as successful as 4-year-olds in correctly attributing knowledge of the dinosaur's color and perceptual experience to the individual who had seen the hidden contents, and denying these to the one who had not. A similar task involving two puppet viewers yielded the same results. The authors proposed that the discrepancy between their and others' findings may be explained in terms of the kind of knowledge that children were asked to consider. Specifically, they suggested that questioning subjects about object color, a perceptual quality, may have highlighted the relevance of perceptual experience, more so than would questions about an object's identity.

Pratt and Bryant (1990) hypothesized that 3-year-olds' failure in the Wimmer et al. study (1988) was due to the complexity of the test questions (e.g., "Does he know what is in the box, or does he not know that?"). To test this idea, they readministered the original task using a simpler question. With this modification, 75% of 3-year-olds successfully passed the task, suggesting that they do associate seeing and knowing. Despite these positive findings, Pratt and Bryant's study has been criticized on the grounds that the instructions provided may have allowed children to solve the tasks via simple strategies that do not require an understanding of how vision functions as a knowledge-acquisition device (Povinelli & DeBlois, 1992). In addition, some of the apparent discrepancies in this area may relate to the definition of age groups. For instance, it appears that in studies showing an understanding that seeing leads to knowing, 3-year-olds tended to be older than in other studies (Povinelli & DeBlois, 1992).

While numerous studies have examined understanding of the perception-knowledge relationship in preschoolers, only a handful of studies have examined this ability in younger children. Pillow and Brownell (1991) hypothesized that infants may be implicitly aware of others' knowledge states and that this implicit understanding is manifested in their social interactions. To test this idea, they created two interactional tasks in which 2-year-olds (M = 31 months) were provided with a motive for considering the knowledge status of another person. Specifically, young children were placed in a situation where they needed to elicit help from one of two adult helpers (knowledgeable and ignorant) in order to obtain a desirable object, or to operate an interesting mechanism. In the operating task, for example, the operation of a complex mechanism was demonstrated while one of the adult helpers watched and the other helper read a book. Subsequently, subjects were asked to choose one adult to help them in operating the mechanism (or to retrieve the hidden object in the hiding task). In the operating task, only 48% of children chose the knowledgeable adult. Performance was somewhat better in the hiding task where 62% of children chose the correct (knowledgeable) helper. These findings suggest a beginning awareness in 2

1/2-year-olds that having knowledge may depend on ones' past perceptual experience.

O'Neill (1996) attempted to test the same kind of understanding using a hiding task as well. In Experiment 1, 2-year-olds ($\underline{M}$ = 31 months) had to request their parent's help in retrieving a toy placed in one of two containers on a high shelf. On some trials, called "parent knowledgeable" trials, the parent witnessed the placement of the toy along with the child. On "parent ignorant" trials, parents were instructed to leave the room, or to cover their eyes and ears while infants watched the hiding of the object alone. Of interest was whether infants would modify their requests for assistance in accordance with the parent's knowledge state, which was inferable from her previous perceptual experience. As predicted, children communicated more information (i.e., named the toy, and attempted to identify its location verbally or through gesture) more often when parents did not witness the hiding than when they did. In a second study, in which children had to recruit their parent's help in retrieving a sticker placed in one of two identical containers located out of reach, similar results were obtained in even younger children ($\underline{M}$ = 27 months).

While the findings of these studies are consistent with the possibility that 2-year-olds understand that seeing leads to knowing, they may be accounted for in a simpler way. Specifically, it is possible that young children are inclined to "update" their communication partners on significant aspects of a situation whenever the partner appears "disengaged" in any way (O'Neill, 1996). According to this view, children may simply realize that the parent has become disengaged, without necessarily recognizing that one of the parent's specific perceptual capacities (e.g., vision) has been negatively affected. Similarly, it has been speculated that even 3-year-olds' understanding of the perception-knowledge relationship may not reflect genuine appreciation of the causal link between sensory experience and knowledge, but rather a simple associative understanding that perceptual activities and knowledge tend to go together (O'Neill, Astington, & Flavell, 1992; Pillow, 1993).

To date, understanding of the perception-knowledge relationship has not been assessed in children under 2 years of age. However, there are indications that toddlers do understand something about seeing and attending, upon which the understanding of the perception-knowledge relationship may depend. While the terms perception and attention are sometimes used interchangeably (e.g., Wellman, 1993), others distinguish the two. Baron-Cohen (1991), for example, has hypothesized that children understand perception (e.g., seeing) before they gain an understanding of attention, defined as the recognition that perceptual activities such as looking or hearing can be directed selectively, depending on what a person finds to be of interest. Supporting this distinction, autistic children appear to understand seeing without understanding attention (Baron-Cohen, 1991).

Several infant behaviors, such as showing and hiding objects in the presence of another person, are frequently interpreted as reflecting understanding of people as perceiving agents. In an early study, Lempers, Flavell, & Flavell (1977) administered a number of tasks to young children in an effort to tap this type of understanding. On showing tasks, children were presented with a toy or with a picture that was glued to a piece of cardboard, the face of a wooden block, or on the inside of an open hollow cube. When asked to show the object (or picture) to another person facing them, 12-month-olds were able to show (as opposed to giving) toys, but seemed confused as to what to do with the pictures. Eighteen-month-old children were able to show the pictures, but regularly did so by standing alongside the observer in such a way that they themselves could see the picture. Only by 2 years did children demonstrate the adult pattern of orienting the pictures away from themselves and towards the observer. While children's performance on hiding tasks appeared to lag behind their ability to show in this study, this may well be due to the greater task demands in the hiding tasks, which required some problem solving.

In order to assess children's understanding of the role of the eyes in seeing, Lempers et al. (1977) instructed observers to cover their eyes with their hands, or to close their eyes, during some of the showing tasks. While most 18-month-olds removed the observer's hands from her eyes in order to create an unobstructed path, 18- and 24-month-olds often failed to open the observers' eyes when they were shut. Furthermore, on tasks where children had to indicate which toy a person "sees" based on gaze direction and head orientation cues, 18- and 24-month-olds frequently made mistakes when eye and head cues were discrepant, erroneously basing their judgments on head orientation. However, as the authors themselves point out, children may simply not have noticed eye orientation.

In addition to showing and hiding things, infants often respond socially in ways that suggest an understanding of attention. Specifically, they engage in apparent attempts to direct other people's attention by pointing from as young as 9 months of age and will visually follow other people's points. While some of the infant's early pointing gestures are probably just actions toward the object itself, or conditioned responses serving a request function, others appear to be deliberate attempts to get another person to attend to something. This is suggested by the fact that, during the second year, infants will point while seemingly monitoring the other person's gaze by alternating their gaze between the target object and the communication partner (Bates, Camaioni, & Volterra, 1975; Butterworth & Franco, 1996; Lempers et al., 1977).

While a number of researchers believe that pointing and related behaviors reflect a simple understanding of attentional states (Baron-Cohen, 1991, 1993), or even more cognitively complex mental states such as knowing and comprehending (Bretherton, McNew, Beeghly, & Smith, 1981), others reject this interpretation. Perner (1991), for example, suggests that pointing and gaze monitoring in infancy may simply constitute attempts to influence another person's looking behavior. Thus, infants may "enjoy having mastery over their mother's eyes" without any accompanying understanding of her internal mental experience. Perner suggests that children do not appreciate the experiential aspect of attention and visual experience until the age of 2 years, at which age they can show pictures without needing to see them at the same time (Lempers et al., 1977).

In summary, there is some evidence to suggest that 3-year-olds appreciate the relationship between seeing and knowing, though children's construal of this relationship may be more properly described as associative than causal. Very few studies have addressed understanding of the perception-knowledge relationship in children under 3 years. The results of these few studies suggest that when provided with a motive for considering another person's knowledge state, children as young as 27 months show an awareness of the link between seeing and knowing (O'Neill, 1996). Nevertheless, simpler accounts of 2-year-olds' success have been offered which do not ascribe a sophisticated understanding of this relationship (O'Neill, 1996). In addition, it remains unknown whether 2-year-olds can use information about perceptual experience to infer what a person knows in situations where no incentive is provided for considering the mental state of another person. Concerning the understanding of children under 2 years, infants appear to attribute attentional states to other people beginning in the second year, at which time they engage in apparent attempts to manipulate the attention of those around them.

Young Children's Reasoning about Desires

The Role of Desires and Intentions in Human Action

The understanding that human actions are framed by a person's beliefs has mainly been assessed through tasks in which children are required to predict a person's actions on the basis of information about what he or she believes. Action-prediction tasks have also been used to test children's understanding of the role of desires in human action. For example, in a study by Wellman and Woolley (1990), young children were given information about the desires of various story characters and were then asked to make predictions about those characters' actions. Even 2 1/2-year-olds were able to make accurate predictions in this context (e.g., they predicted that a little boy who wants to find his pet to take to school will continue searching if he fails to find it, but will continue on to school if he does). Using similar tasks, Yuill (1984) established the same type of understanding in 3-year-old children.

Other evidence that children as young as 2 years appreciate the causal role of desires in human action comes from an analysis of the kinds of explanations that children provide for human actions in the context of their everyday conversations (Bartsch & Wellman, 1995). Bartsch and Wellman examined transcripts of natural language samples for cases in which children explicitly explained a person's action (or inaction) by invoking the actor's belief or desire. Such explanations often occurred in the context of "Why?"

questions, such as "Why did he do that?" The results of this analysis suggested that from the age of 2 years onward, children regularly explain people's actions by appealing to desires. Similarly, in tasks where subjects are told about a character's completed action and are asked to explain that action, 3-year-olds commonly make reference to the character's desires (Bartsch & Wellman, 1989; Moses & Flavell, 1990).

Although understanding of desire-dependent action has not been specifically assessed in infancy, children's early use of terms denoting desire states (e.g., wish and want) and certain naturally-occurring behaviors, such as teasing and giving, have been interpreted to reflect an understanding of desires, without which an understanding of desire-dependent action would not be possible. Bartsch & Wellman (1995) examined use of desire terms in the natural language productions of young children and found evidence of genuine references to desires from as early as 18 to 22 months of age in some children. Moreover, children's utterances indicated an ability to distinguish desires from associated outcomes and actions, suggesting an early understanding of desires as experiential states. Finally, subjective contrasts (statements in which a child acknowledged that one person may find an object or event desirable while another person does not) appeared in children's talk around 2 1/2 years, indicating an early appreciation of the subjectivity of desires.

In general, expressive language is considered a conservative estimate of understanding, meaning that children may understand desires even prior to the age at which they make reference to desires in their everyday conversation. Consistent with this possibility, in a study of 9- to 18-month-old infants, Masur (1983) found that infants as young as 12 months frequently gave objects in response to nonverbal cues about their mothers' desires, such as palm-up requesting gestures. Additionally, there is some evidence that 18-month-olds appreciate the subjectivity of desires as reflected by the fact that they are unwilling to extend one person's food preference to another adult whose preference they have not learned about (Poulin-Dubois & McKoy, in prep.). Another indication that infants understand and attribute desires to other people is that they appear to play and tease with other people's desires. For example, 12-month-old infants have been observed to offer an object to another person, only to withdraw it in amusement as a person reaches to take it (Reddy, 1991).

Wellman (1993) proposed that the teasing behavior of 12-month-olds reflects a simple nonrepresentational conception of desire, in which others are construed as seeking to attain real objects, actions, or states of affairs, as opposed to mentally represented ones. However, giving and teasing behaviors are open to multiple interpretations. For instance, rather than reflecting a genuine mentalistic understanding of desires, teasing behaviors may be learned through social reinforcement provided by parents. Nevertheless, as Reddy (1991) points out, a contribution of learning to infant behaviors like teasing need not exclude the possibility that the infant attributes mental states to the other person.

The ability to attribute desires need not imply an understanding of the relationship between desires and actions. Recently, however, a handful of studies have suggested that even this knowledge may be possessed by young infants. Concurrent with the present study, Spelke, Phillips & Woodward (1995) devised a nonverbal test procedure and found that infants were puzzled by a person's actions when those actions conflicted with earlier-presented information about the person's desire. In their study, 8- and 12-month-olds saw an actress gazing with a joyful expression at one of two stuffed toys located on opposite sides of a table. Following a brief interval, during which a curtain was drawn, blocking the actress from view, infants were shown the actress reaching for her desired toy (congruent action) or the nondesired toy (incongruent action). Unlike the youngest subjects who showed no comprehension, 12-month-olds looked significantly longer at incongruent outcomes than the congruent outcomes, with 11 out of 16 children demonstrating this response pattern. These findings suggest that by 12 months, children have some knowledge of the connection between desires and actions. One cannot say which of the desire cues provided (gaze direction or emotional expression) was most critical, since both were provided simultaneously. Furthermore, as the authors note, these results may simply reflect a learned association between external facial expressions (e.g., joyful expression) and behavioral dispositions (e.g., approach behavior), rather than a true appreciation of perception and emotion as internal experiential states. Nonetheless, the results are at least consistent with the interpretation that infants recognize the causal role of desires in approach behaviors.

In addition to desires, a number of researchers have proposed that young children may attribute intentions to other people. However, it should be noted that intentions are not always defined in same manner. A useful distinction may be made between what Bratman (1984) has described as future-directed intention and "intention-in-action." A future-directed intention is a mental plan for action that is separate from a person's subsequent action and from desires. It is therefore possible to have a desire without an intention to act on that desire, and for a desire to be satisfied without intentions ever coming into play (Astington & Gopnik, 1991b; Wellman, 1990). The term intention-in-action, in contrast, is used to describe the fact that some actions are intentional in the sense of being carried out on purpose in the interest of acheiving a current goal. In the latter construal, the action reflects the goal, but may not be distinguished from it. In general, it is the latter construal of intentions, and not the former, that has been attributed to young children and infants (e.g., Wellman, 1990).

Astington and Gopnik (1991) suggested that very young children do not fully distinguish between desires and intentions, but may think of these entities indiscriminately as goal states. Consistent with this view, there is evidence that 4-year-olds disregard information about an actor's plan for action when judging whether or not he acted intentionally. Instead, they based intentionality judgements on whether the actor's desire was fulfilled or not (Schult & Wellman, 1997). Thus, children can determine whether an actor's desire was satisfied well before they can judge whether the actor's plan to complete an action was also satisfied. With regard to younger children, it is speculated that 18-month-olds and younger infants may lack the ability to separate both plans for action and desires from subsequent actions (Gopnik & Meltzoff, 1997). For instance, Gopnik and Meltzoff proposed that while not physicalistic, young children's conception of action is "not mentalistic in a sense that involves a conception of desires or intentions as mental entities separate from the actions they lead to." Instead, infants are proposed to understand actions as being on-purpose or goal-directed, without understanding that people have prior mental states which determine their subsequent actions.

One indication that 18-month-olds understand goal-directed actions is their ability to infer another person's goal from a wrongly performed action. In a study by Meltzoff (1995), infants observed an actor performing successful or unsuccessful actions involving novel toys, and were then given the opportunity to spontaneously imitate those actions. Of special interest were infants' responses in the condition where the actor attempted to perform an action (e.g., insert a peg in a hole), but failed. The results showed that children who saw the failed attempt proceeded to produce the intended rather than the observed action, suggesting an ability to infer another person's intention or goal on the basis of behavioral cues. Moreover, infants did not react this way when a mechanical device performed the same failed actions as the actor.

Further evidence that infants understand goal-directed actions comes from a verb learning study by Tomasello and Barton (1994). In this study, an experimenter announced his intention to perform an action while introducing a novel verb (e.g. "Let's dax Mickey Mouse"), and then proceeded to perform two novel actions, one apparently accidental and the other apparently purposeful. Two-year-olds consistently attached the novel verb to the purposeful action and not the accidental action, suggesting an ability to distinguish these categories of action on the basis of behavioral cues. In another study in which infants were presented with accidental and intentional actions (marked vocally with the terms "there" and "woops", respectively), the ability to distinguish goal-directed actions from accidental ones was demonstrated in children 16 months of age (Carpenter, Akhtar, & Tomasello, 1996).

One way in which infants may attempt to discover another person's goal is through eye-contact. Phillips, Baron-Cohen, and Rutter (1992) hypothesized that when infants are uncertain about the intention associated with a person's behavior, they will try to decipher it by establishing eye contact. To test this idea, adults were instructed to interact with young children in ambiguous ways (e.g., offering then withdrawing an object in a teasing manner) and in unambiguous ways (e.g. giving an object). The results confirmed that both normal and developmentally-delayed infants established eye contact with the actor in the ambiguous action condition, but not in the unambiguous condition. In contrast, autistic children, who have well-documented deficits in understanding beliefs, rarely established eye contact after either kind of action, despite their normal levels of eye contact in some other situations.

Visual cues seem important not only when infants are trying to decipher the goal behind a strange action, but also when they are attempting to identify the intended referent for a novel word uttered by a speaker (Baldwin & Moses, 1994). Baldwin and Moses demonstrated that infants as young as 18 months make use of a speaker's gaze direction in selecting the correct referent for a novel label, suggesting that infants interpret gaze direction as signaling something about a speaker's "referential intent." In addition, they found that infants as young as 12 months will use gaze cues to determine the target (object) of an adult's vocal affect in a social referencing situation.

In summary, research employing action-prediction and explanation tasks suggests that preschoolers and older 2-year-olds understand the causal role of desires in human actions. Furthermore, there are indications that infants as young as 12 months attribute desires and goal states to other people. Infants this age also seem to expect people to approach objects towards which they have previously displayed interest and positive emotion, which is at least consistent with an understanding of desire-dependent action.

The Role of Desires in Emotional Reactions

Just as a person's beliefs and knowledge status are related to reactions of surprise and curiosity, desires also play an important role in some emotional reactions, referred to as desire-dependent emotions. As discussed earlier, desire-dependent emotions occur when a person's desire is thwarted or satisfied, and include states such as happiness, sadness, and anger. Young children's understanding of desire-dependent emotions has been studied using similar methods as for belief-dependent emotions, that is, using emotion prediction and explanation tasks.

In order to assess children's understanding of desire-dependent emotions, Yuill (1984) asked 3-, 5- and 7-year-old children to predict a story character's emotional state (happy or sad) following an outcome that was either consistent or inconsistent with that character's desire. The results indicated that children as young as 3 1/2-year-olds accurately judge a character's happiness to depend on whether an outcome is desired or not. In a similar study, Stein and Levine (1989) asked children to predict and explain a story character's emotional reaction (i.e., happy, sad or angry) in narratives encompassing all possible combinations of goals and outcomes. Again, children as young as 3 years accurately predicted how the character would feel. In addition, when asked to justify their predictions, children this age referred to the protagonist's desire over 65% of the time. Astington and Gopnik (1991b), Harris et al. (1989), and Hadwin and Perner (1991) all found a similar understanding in 3-year-olds.

Understanding of desire-dependent emotions was also demonstrated in older 2-year-olds using a simplified emotion-prediction task (Wellman & Woolley, 1990). In this study, older 2-year-old children were told stories about small cardboard characters who wanted a specific object, such as a dog, and who after searching either found the desired object, found nothing, or found a different object. Children accurately predicted that only the characters who found their desired object would be happy, while the others who had not found their desired object would be sad.

Understanding of desire-dependent emotions has not been systematically studied in children under the age of 2 1/2 years. Nonetheless, one study, designed concurrently with the present study, obtained results suggesting children as young as 18 months understand something about the relationship between emotions and food preferences, which are similar to desires (Repacholi & Gopnik, 1997). In this study, 14- and 18-month-old children were given emotional cues (facial expression and vocal cues) about an actor's food preference, and were then tested to see if they could infer which food the experimenter wanted. At the beginning of the task, children watched as an experimenter tasted two foods, cheese crackers and broccoli flowerets, reacting to one with pleasure (Mmm!) and to the other with disgust (Ewww!). The experimenter then asked the infant for more food with a palm up gesture, being deliberately ambiguous as to which food was requested. The results indicated that 18-month-olds were quite accurate at inferring another person's food preference from emotional cues even when that preference differed from the child's own, ruling out the possibility that children were egocentrically attributing their own preference to the experimenter. In contrast, 14-month-olds responded egocentrically, consistently offering the food that they themselves preferred. These findings suggest that sometime between 14 and 18 months, children come to appreciate the link between food preferences and emotional expressions (facial and vocal) of pleasure and disgust. However, the generalizability of these findings to other emotions and desires is unknown.

Regarding younger children's understanding of desire-dependent emotions such as happy and sad reactions, there are several indications that such emotions may be understood very early in development. Emotion words are found to enter the child's productive vocabulary late in the second year (Bretherton & Beeghly, 1982; Ridgeway, Waters, & Kuczaj, 1985). Wellman, Harris, Banerjee, and Sinclair (1995) examined children's emotion language from 2 to 5 years using natural language samples and found that by 2 years of age, children used terms denoting the basic emotional states of happiness, sadness, fear, and anger. Moreover, an analysis of usages suggested that children as young as 2 years distinguish emotional states (e.g., anger, happiness) from actions and expressions associated with those states (e.g., yelling, smile), implying that they do not construe emotions in a purely behavioral fashion. Knowledge of the subjectivity of emotions was also apparent prior to the age of 3 years in most subjects, as indicated by children's spontaneous discussion of contrasting emotional reactions to the same object (Wellman et al., 1995). In sum, this study demonstrated evidence of a subjective-experiential conception of emotion by age 2 1/2 or earlier.

As discussed in the context of children's early understanding of beliefs, infants begin to distinguish different emotional expressions from some time between 4 and 7 months of age. Late in the first year, they seem to recognize specific expressions, despite changes in the model, suggesting a categorical understanding of these expressions. While these are important achievements, they do not tell us whether infants perceive these expressions as reflecting something about a person's internal state. One indication that they do recognize the meaning of emotional expressions is the finding that they will modify their behavior appropriately in accordance with a caregiver's facial expressions in situations where they don't know what to do, a phenomenon referred to as social referencing. This naturally occurring behavior has been explored in social referencing studies by placing infants in an ambiguous situation and having an adult display specific emotional expressions such as anger, fear, or joy.

In one such study (Sorce, Emde, Campos, & Klinnert, 1985), 12-month-old infants were placed on one side of a "visual cliff" opposite their mothers who were instructed to pose different facial reactions intended to provide infants with information about the dangerousness of the cliff. The visual cliff consists of a glass surface with a pattern beneath it creating the visual illusion of a sharp drop off. It was found that none of the infants crossed the cliff when their mothers posed a fearful expression and only 2 out of 18 children crossed when an angry expression was posed. In contrast, the majority of infants crossed if the mother posed a happy or interested expression. One shortcoming of this and other social referencing studies is that they do not reveal much about the infant's understanding of specific emotions. For instance, it is possible that infants' behavioral reactions in the visual cliff situation were based on a general distinction between positive and negative affect. Nonetheless, this in itself would constitute an important step in acquiring an understanding of desire-dependent emotions which may all be described as either positive or negative.

Another social referencing study conducted by Hornick, Risenhoover, and Gunnar (1987) provided evidence that infants not only modify their behavior in accordance with another person's emotional expression, but also construe emotions as being directed towards particular objects or events, thus ruling out the possibility that behavioral changes in infants are achieved via a direct effect of the mother's expression on the baby's mood. In Hornick et al's study, mothers posed an emotional expression such as fear toward a particular target toy in a situation involving several toys. Twelve-month-olds subsequently avoided the target toy but played with the other toys, suggesting that they understood the mother's affect as pertaining to a specific toy, and were not simply responding to her affective state.

Another indication that young children understand the affective displays of others are naturally occurring "empathic" behaviors that are sometimes seen in toddlers. In a longitudinal study, Zahn-Waxler and Radke-Yarrow (1992) found that children's reactions to another person's distress changed over the course of infancy. Whereas 10- to 12-month-olds remain unresponsive or become distressed themselves in reaction to another's distress, 18-month-old children perform a number of behaviors seemingly intended to get the other person to feel better. For example, they are observed to approach and pat the distressed person, to give objects or advice, or to go for help. In line with the developmental sequence seen for comforting behaviors in infancy, teasing behaviors that are seemingly intended to alter another person's emotional state also become increasingly frequent during the second year (Dunn & Munn, 1985). Typical teasing behaviors at this age include the removal of an older sibling's comfort object, or looking at the mother and smiling while carrying out a forbidden act.

In summary, infants demonstrate an understanding of emotions as being about something from as early as 12 months. The fact that they modify their behaviors in appropriate ways in response to their caretaker's emotional expressions suggests that infants may recognize the meaning, or internal state, connected with emotional expressions. Nonetheless, it remains unclear whether responses in social referencing studies are based on an understanding of <u>specific</u> emotions, or rather on a more general distinction between negative versus positive affect. In addition, there is disagreement as to whether social referencing and empathic behaviors truly reflect a <u>mentalistic</u> understanding of emotions, or a simpler conception of emotions based on the external expressive components alone. Perner (1991), for example, argues that infants may learn the "environmental meaning" of maternal displays through instances where they ignore such information and encounter negative experiences. Similarly, it is possible that young children learn to comfort others by imitating behavior sequences regularly observed in the environment around them.

As discussed earlier, one potential source of information concerning young children's understanding of emotions is production and comprehension of various emotion words. Studies of children's production of emotion terms suggest that words denoting the desire-dependent emotions happy and sad are present in the child's vocabulary by the second year. For example, Bretherton and Beeghly (1982) had mothers report on their 28-month-old children's use of specific internal state words, the assumption being that use of such terms provides a rough index of comprehension. Having eliminated clearly imitative and inappropriate uses of emotion terms, it was found that happy and sad were used by 60% and 57% of children respectively. Mad and scared were each used by 73% of 28-month-olds. In contrast, surprise was used by only 13% of children. In a different study assessing comprehension of different emotion labels, children were presented with words (e.g., sad, angry, or surprised) and asked to point to one of four photographed faces that matched the label (Michalson & Lewis, 1985). In this task, 2-year-olds were over 80% accurate at recognizing both the happy and sad faces. However, in another study where children had to match emotion labels to videotaped expressions, fewer 2-year-olds recognized the sad face (33%) than the happy face (80%), suggesting that children had some difficulty identifying the sad face when it was paired with the other faces.

Concerning 2-year-olds' knowledge of the kinds of situations that typically elicit happy and sad reactions, one study found that 70% of 2-year-olds correctly pointed to the photograph of a happy face when asked how a girl would feel at a birthday party. In contrast, only 30% of children this age correctly chose the sad face when asked how a girl would feel if her dog ran away (Michalson & Lewis, 1985). In another task, where children were required to point to one of two filmed situations that might evoke a particular emotion, which was named, none of the 2-year-old subjects showed knowledge of the types of situations that typically elicit happy and sad reactions, possibly reflecting inappropriate task demands (Smiley & Huttenlocher, 1989). Consistent with this possibility, even young 3-year-olds had difficulty identifying situations associated with happy (20%) and sad (27%) reactions in this task, despite their good performance in other studies.

In summary, empirical findings support an understanding of desire-dependent emotions in older 2-year-olds. By this age, children recognize that people experience happiness and satisfaction when their desires are fulfilled, and sadness or anger when they are not. Understanding of desire-dependent emotions has not been systematically studied in children under the age of 2. However, one study found that 18-month-olds can infer a person's food preference, which may be considered a kind of desire, from emotional cues. It should be noted, however, that inferring a desire from emotional cues does not amount to the understanding that emotional reactions may be caused by a person's prior desire and an outcome relevant to that desire. The latter kind of understanding has not to date been tested in children under 2 years of age.

The Present Study

The present study consisted of three experiments and was intended to investigate 18- to 30-month-olds' understanding of specific mind-world and mind-mind relationships involving beliefs and desires. Three experiments, each consisting of two tasks each were conducted: Experiment 1 (Perception-Knowledge task and Belief-Emotion task), Experiment 2 (Desire-Action and Desire-Emotion tasks), and Experiment 3 (Desire-Action and Desire-Emotion Follow-up tasks). Experiment 1 examined young children's understanding of the link between visual perception and knowing, and their understanding of the belief-based emotion, surprise. Experiment 2 was designed to evaluate young children's understanding of the role of desires in human actions and emotions. Experiment 3 further examined children's understanding of desire-dependent action and emotion, while aiming to resolve some interpretive difficulties associated with Experiment 2.

The methodological approach was the same for all three experiments. As the kinds of tasks commonly used to test preschoolers' understanding were judged too taxing for very young children, each of the experiments was conducted using an adaptation of the preferential looking paradigm, a nonverbal method frequently used in investigations of infant cognition (Spelke, 1985). In standard preferential looking tasks, the infant is presented with two visual displays simultaneously and looking time to each display is recorded. The advantage of studying looking preferences is that the infant's visual system is relatively more advanced than other expressive behaviours such as speaking, pointing, and reaching. In addition, looking behaviours are important because they tell us something about an infant's existing knowledge. Previous research using the preferential looking method has revealed two general patterns of visual preference in infancy: 1) infants prefer to look at objects or events that are relatively novel or unexpected, and 2) infants attend to objects or events that match a related sound, in preference to objects paired with an unrelated sound. The latter pattern is considered to reflect a common tendency to explore one object or event at a time.

In our adaptation of the preferential looking technique, 18- to 30-month-old infants were administered a series of trials, each of which began with a single dynamic display in the form of a videotaped story, and ended with two static displays constituting different conclusions to the videotaped story. In the initial dynamic display, children were given information consisting of verbal and nonverbal cues about a female protagonist's mental state (desire or belief). In the two static displays that followed, infants saw the same protagonist behaving in a manner that accorded with her previous mental state in one display (congruent stimulus), and in a manner that conflicted with her previous mental state in the other display (incongruent stimulus). Infants' looking behaviors were recorded throughout the entire trial. Of interest was whether total looking times to the two static displays, representing the two different story endings, would vary as a function of the information provided in the initial scenario about the mental state of the protagonist. Given infants' tendency to attend to events that are novel or unexpected, a general prediction was that they would show longer fixations to the screen which showed the protagonist behaving in a way that conflicted with her previous mental state.

As mentioned earlier, one objective of this research project was to evaluate understanding of the causal aspect of mind in younger children using a methodology that capitalized on a relatively advanced expressive behavior in infancy, looking preferences. One major hypothesis associated with the Theory theory is that understanding of desires precedes the understanding of beliefs developmentally (Wellman, 1993). Assuming this characterization is correct, then our subjects were expected to perform better on tasks requiring an understanding of desires than on tasks requiring an understanding of beliefs. Another hypothesis is that until shortly before their third birthday, most children operate without any conception of belief (Wellman & Woolley, 1990). If this is correct, then very few of our subjects would be expected to pass either of the tasks in Experiment 1, particularly 18- and 24-month-old children. That is, they would not be expected to understand how perception relates to knowledge, or how surprised reactions relate to pre-existing knowledge, for the reason that they do not understand beliefs in the first place. Success on the Belief-Emotion task in any of the age groups tested would not only conflict with the Theory theory, but would also call into question a widely-held assumption which is that the understanding of surprised reactions necessarily requires an understanding of false beliefs, an achievement commonly believed to occur around age four (e.g., MacLaren & Olson, 1993; Wellman, 1995).

CHAPTER TWO: BELIEF EXPERIMENT

Experiment 1: The Belief Experiment

The purpose of Experiment 1 was to assess young children's understanding of the perceptual origins of knowledge (Perception-Knowledge Task), and their understanding of the cognitive basis of surprised reactions (Belief-Emotion Task). Concerning children's understanding of the perceptual origins of knowledge, previous research suggests that children as young as two years may appreciate this aspect about the mind (O'Neill, 1996; Pillow & Brownell, 1991). Given the success of 2-year-olds in previous research, 30-month-old subjects were expected to pass the simple version of the Perception-Knowledge task of Experiment 1 without difficulty, unless for some reason they can only demonstrate this knowledge when provided with a motive for considering the other's mental state. Similarly, 18- and 24-month-olds were expected to pass the Perception-Knowledge task, given that greater understanding is sometimes demonstrated in young children when they are allowed the opportunity to respond nonverbally rather than verbally (Clements & Perner, 1994).

The Belief-Emotion task was designed to test whether 18- to 30-month-old children possess a mental-state conception of surprise, i.e., the understanding that surprise occurs when a person's previous belief or knowledge state has been violated. As this understanding has never been tested in children under 3 years of age, it was not known whether children in any of the age groups tested would pass this task. Currently, most investigators consider that the understanding of belief-dependent emotions like surprise is a relatively late acquisition (McLaren & Olsen, 1993; Ruffman & Keenan, 1996). Nonetheless, we predicted that in a task where children are not required to provide a verbal response, greater competency might be demonstrated than has been found previously. The finding that some 2-year-olds and nearly half of 3-year-olds show knowledge of the kinds of situations that cause surprised reactions (Michalson & Lewis, 1985) strengthened our expectation that 2-year-old children and even 18-month-olds might demonstrate some implicit understanding that surprised reactions correspond to a person's knowledge state.

Method

Participants

One hundred and eight children (95 anglophone and 13 francophone) falling into three separate age groups (18, 24, and 30 month samples) participated. Children were recruited from birth lists obtained from the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre after approval by the Commission d'Accès à l'Information du Québec. Four 18-month-olds were eliminated because of crying, and one 24-month-old child was eliminated due to equipment failure. The final sample consisted of 103 children. Demographic data were computed on these children for the 3 age groups separately. The mean age of participants in the different age groups was 18.59 months (SD = .56), 24.19 months (SD = .48), and 29.97 months (SD = .49). Children's socioeconomic status was estimated using occupational ratings of the Blishen, Carroll and Moore (1981) index (M = 42.74, SD = 13.28). A child's SES score was based on the highest occupational score assigned to either parent. The mean socioeconomic scores in the 18-, 24- and 30-month samples were 60.50 (SD = 20.13), 57.09 (SD = 12.55), 53.67 (SD = 16.02), respectively. The fact that SES scores varied only slightly as a function of age group suggests that participants were from similar socioeconomic backgrounds.

Apparatus

Infants were tested using an adaptation of the preferential looking paradigm (see Appendix A). The child was seated in a booster seat or clip-on chair attached to a table, or if necessary in the parent's lap, as described below. On a second table, 120 cm in front of the child and parent, were two NEC 19-inch color monitors positioned 35 cm apart. A black curtain provided the backdrop for the two television monitors and served to conceal the audiovisual equipment used in the experiment. Between the two monitors and concealed from the infants' view was a Foxtex 630113 loudspeaker through which the auditory component of trials was delivered. Children's visual fixations were recorded by a hidden video camcorder (Sony Model No. EVO-120) located 40 cm above the loudspeaker. During the testing session, the experimenter stood behind the curtain where she was not visible to the child, and operated the camcorder.

Stimuli

For each task, videotaped vignettes were developed which differed only in terms of the language spoken by the actors (English or French). The stimuli included two sets of videotaped trials, one for each task. The first set was used in the Perception-Knowledge task and included four trials, each beginning with an "information phase" and ending with a "test phase." The information phase consisted of a videotaped story segment presented on one of the television monitors, while the other monitor remained blank, displaying only a solid blue background. During this phase, children were given information about the story protagonist's perceptual access to an event. Following, the test phase commenced with the onset of two still images, one on each monitor. These images were intended to constitute two different endings (congruent and incongruent) to the story presented during the information phase. Congruent story endings were outcomes that adults would expect to occur on the basis of common-sense reasoning. Incongruent endings were outcomes that violated expectations created during the information phase.

The duration of the information phase for the Perception-Knowledge trials varied slightly from trial to trial due to small differences in the actors' pacing across trials, ranging from 39 to 45 seconds in length for the English version, and from 36 to 44 seconds in the French version. The test phase of each trial was always 10 seconds in duration. Both screens were blank for a brief interval (1.3 seconds) between the two phases to encourage infants to look at both screens during the test phase. In addition, there was a 3-second pause between trials, during which both screens displayed a solid black background. For each trial, three brief tones were delivered through the central speaker. The first tone occurred just prior to the information phase and was intended to orient children to the visual displays. The second and third tones were presented simultaneous with the onset and the end of the test phase. The latter tones let coders know when to begin and when to stop recording children's visual fixations for the test phase.

In the Perception-Knowledge task trials, the information phase began with a female protagonist (Actor 1) seated at a table supporting two overturned buckets, one of which contained a toy and the other which was empty (See Appendix B). Another female actor (Actor 2) stood behind the protagonist. Facing the infant, Actor 2 greeted the viewer, "Hi Baby!," and then announced that they were going to "play a game." She then took a scarf and used it to cover the protagonist's eyes, referred to as the no access trials (n = 2), or mouth, referred to as the visual access trials (n = 2). In the no access condition, the protagonist responded to the placement of the blindfold by saying "I can't see anything," in order to emphasize the effect of the blindfold on her vision. Following this intervention, Actor 2 lifted each of the buckets, one at a time, exposing the location of a hidden object (e.g., toy duck) for the viewer. On visual access trials, the protagonist gazed in the direction of the buckets as they were raised, to emphasize that she saw the location of the hidden toy. In the no access trials, she kept her head straight towards the camera, and did not orient to the buckets as they were raised. Having revealed the toy location, Actor 2 departed and the protagonist removed the scarf covering her eyes or mouth. The information phase of trials always ended with Actor 2 (off-screen) asking the protagonist to indicate the location of the hidden object (e.g., "Hi Judy. Where is my cup?"). During the test phase of each trial, children saw a still frame image of the protagonist pointing to the correct location on one monitor, referred to as the correct point frame, and a second image of the protagonist pointing to the incorrect location on the other monitor, referred to as the incorrect point frame. Accompanying these images was an audio input of the protagonist's voice, saying confidently "It's here." On trials in which the protagonist had seen the object's location, the screen depicting the correct point was considered the congruent stimulus, and the screen depicting the incorrect point was considered the incongruent stimulus. On trials in which the protagonist had been blindfolded, the screen showing the incorrect point was considered the congruent stimulus, and the screen depicting the correct point was viewed as the incongruent stimulus. While it is possible that the protagonist might guess the correct location in the no access condition, making points to either location congruent, this was not suggested by her quick and confident assertion of the toy's location.

A second series of trials (French or English) with a similar structure was developed for the Belief-Emotion task. The duration of the information phase in the Belief-Emotion trials ranged from 19 to 20 seconds in the English version, and from 17 to 20 seconds in the French version. Again, the slight variation in the duration of information phases was due to small differences in the actors' pacing across trials. In the Belief-Emotion task, the information phase of each trial began with a female protagonist (Actor 1) seated at a table on which a single overturned yellow container was placed (See appendix B). Another actor (Actor 2) entered the room carrying an object (e.g., crayon) and announced her plan to conceal the object inside the container ("Look! I have a crayon. I'm going to put it here"). She then placed the object beneath the container and left. Subjects were expected to infer that the protagonist knew the object's location, given that she had witnessed its placement. At this juncture, the protagonist grasped the container with apparent interest, while uttering a sound indicating mild curiosity, "hmmm". She then raised the box, with the obvious intention of seeing the object again.

During the test phase of each trial, children saw two still frame images of the protagonist holding the raised container, and reacting emotionally to its contents. On half of the trials (n = 2), the hidden object was beneath the box where she expected it to be, referred to as the expected event condition, and in the remaining trials (n = 2), the object had been made to disappear through editing of the tape, referred to as the unexpected event condition. On every trial, children saw an image of protagonist reacting to the contents with a surprised expression on one screen, referred to as the surprised image, and another image of her responding with a neutral expression on the second monitor, referred to as the neutral image. Thus, on both expected event and unexpected event trials, one of the screens showed the actress reacting in a typical way to the event, referred to as the congruent stimulus, and one of the screens showed her reacting in an anomalous way, referred to as the incongruent stimulus. For example, on trials where the object disappeared, the screen depicting the surprised face was considered the congruent stimulus, and the screen depicting the neutral face was considered the incongruent stimulus.

In order to ensure that the emotional expressions presented to infants were recognizable exemplars of the emotion in question, independent ratings were gathered from 15 adult participants (6 males and 9 female, M = 23.6) who were tested in small groups. To obtain these adult ratings, six emotional expressions (2 drawn from each experiment) were displayed one at a time on a television monitor in the following fixed order: happy, sad, neutral, surprised, happy, sad. Upon the presentation of each expression, raters were asked to select one of 7 emotion labels (happy, sad, surprised, disgusted, fearful, angry, or neutral) to match the expression displayed. The consent form and instruction and response form given to adult raters are presented in Appendix C. When presented with the neutral and surprised expressions used in the Belief-Emotion task of Experiment 1, all 15 of the adult raters successfully identified the surprised expression. The majority of adult viewers (10 out of 15 subjects) selected the correct label for the neutral face as well, whereas 5 viewers misidentified the neutral face as being surprised, happy, or fearful. Thus the facial expressions used in the Belief-Emotion task seem to have been recognizable examples of surprised and neutral expressions.

Design

The entire experiment consisted of eight trials, including the four trials of the Perception-Knowledge task and the four trials of the Belief-Emotion task. Trials were administered in a fixed order which was arbitrary, such that trials of Perception-Knowledge task were always administered before the Belief-Emotion task trials. While random presentation of trials and counterbalanced task order may have been preferable, this was not feasable due to the very time-consuming nature of editing and synchronizing the videotaped stimuli. A summary of the design is depicted in Table 1. In both tasks, the side of presentation of the information phase (left versus right monitor) was counterbalanced, such that the information phase occurred on the left monitor for half the trials and on the right monitor for the remaining trials. This was done to prevent subjects from forming a preference for one of the monitors. In addition, test phases were designed in such a way that the incongruent test stimulus appeared on the same screen as the preceding information phase on only half the trials. This was done to rule out interpretations of task success in terms of a preference for the test images occurring on the same side as the information phase. The side on which the congruent versus incongruent stimuli were presented during the test phase was also counterbalanced across trials, to rule out side preference interpretations of task success. In the Perception-Knowledge task, we also manipulated the location of the hidden object (left bucket versus right bucket), such that the hidden object was to be found under the right-hand bucket on half the trials and under the left-hand bucket for the remaining trials. In the Belief-Emotion task, the screen (left versus right) on which the surprised and neutral faces were presented was counterbalanced, such that each expression occurred on the right monitor for half the trials and on the

Table 1

Design of Experiment 1

Perception-Knowledge Task

Trial	Object	Condition	Test screen 1	Test screen 2
1	mug	visual access	incorrect (I)	correct (C)
2	toy car	no access	incorrect (C)	correct (I)
3	toy duck	visual access	correct (C)	incorrect (I)
4	ball	no access	correct (I)	incorrect (C)

Belief-Emotion Task

Trial	Object	Event Type	Test screen 1	Test screen 2
5	keys	expected	neutral (C)	surprised (I)
6	crayon	unexpected	neutral (I)	surprised (C)
7	banana	expected	surprised (I)	neutral (C)
8	doll	unexpected	surprised (C)	neutral (I)

Note. In the Perception-Knowledge task, incorrect and correct refer to protagonist's accuracy in locating the hidden toy. In the Belief-Emotion task, expected events are events consistent with what the protagonist knows based on her visual experience. Unexpected events are events that violate what the protagonist knows. Surprised and neutral refer to the protagonist's facial expression in response to these events.

left monitor for the remaining trials. Event type was also counterbalanced in the Belief-Emotion task, such that half the trials involved an unexpected event (toy disappearance), while the remaining trials showed an expected event (toy remains inside container).

Procedure

Participants were recruited from birthlists provided by the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre after approval by the Commission d'Accès à l'Information du Québec. Parents were sent a letter describing the aims and details of the study, and were subsequently contacted by phone and asked if they wished to participate. Participants were tested in the Child Study Laboratory at the Centre for Research in Human Development at Concordia University. All children were tested individually.

Prior to testing, the child and his or her parent met with the experimenter in a reception area for a brief familiarization period. Parents were asked to complete a consent form (see Appendix D) and to read a set of written instructions (see Appendix E) at this time. While parents completed these tasks, children were given the opportunity to play with some toys and to interact with the experimenter. The parent and child were then escorted to the testing room, where the child was seated in an infant chair that clipped on to a table. The child was seated facing two television monitors with the parent seated behind the child. Alternatively, if necessary, the child sat on the parent's lap. In the few cases where children sat on the parent's lap, the parent was instructed to look directly at the camera (located between the two monitors) and to remain as still as possible. This was done to prevent parents from providing possible cues about the "correct" response through their nonverbal behavior. The videotapes were played and the infant's visual fixation was recorded using a concealed video recorder. Once testing was over, the infant and parent were escorted back to the reception room. Upon completion of the study, the child was given a certificate of merit for his or her contribution to science and parents were sent a brief description of the results.

Results

Interobserver Agreement

For each task, two observers who were blind to the position of the congruent and incongruent screens recorded looking times at the right and left screens during the test phase across all four trials for a randomly selected 20% of the subjects. Interobserver reliability was assessed using a Pearson's product-moment correlation between the two observers' ratings for the Perception-Knowledge and Belief-Emotion task separately. Two correlation coefficients were obtained for each task (i.e., time on the right screen and time on the left screen) and were then averaged. Mean interobserver reliability was $r = .958$ for the Perception-Knowledge task and $r = .976$ for the Belief-Emotion task.

Data Screening

Cumulative visual fixation time to the screen displaying the information phase, and to each screen during the test phase was recorded for each trial. Cumulative visual fixation refers to the total amount of time a child attended to a particular screen during the phase in question. During the ten second test phases, children typically scanned back and forth between the two monitors, so that fixation time to a test image usually represented the sum of several brief fixations. Based on children's fixation times in seconds to the two test images, percentage scores were also computed representing the proportion of time spent on a given screen out of total "on-screen time" (the amount of time that a child attended to both test screens combined on a trial). The highest possible on-screen time was 10 seconds. Percentage scores were of interest because, unlike raw scores, they assign equal weight to each trial, regardless of the child's absolute looking time on a trial. As mentioned earlier, cumulative visual fixation to the target screen during the information phase was also obtained for each trial, in order to ensure that infants had paid sufficient attention to this critical portion of the videotaped scenario.

Prior to data screening, the data were cleaned to ensure that only valid data were included in the analyses. Test trials and subjects were eliminated from analyses if they did not meet certain prespecified criteria. Trials were eliminated if (a) cumulative visual fixation to the active screen during the information phase amounted to less than 80% of the information phase duration for that trial, (b) total visual fixation to both screens combined during the test phase was less than 25% of the total test phase duration (c) visual fixation to one of the test screens was zero, indicating that the child failed to attend to one of the test images on that trial. Subjects were eliminated from all analyses on the basis of the following criteria: a) if they exhibited a side bias, which was defined as looking 65% or longer at one screen (left or right) across all eight trials of the experiment; or (b) if the subject lacked the data necessary to compute all dependent variables in a given task. These criteria are similar to those used in previous research using the preferential looking paradigm (e.g., Poulin-Dubois, Serbin, Kenyon, & Derbyshire, 1994; Reznick & Goldfield, 1992).

Having cleaned the data in this fashion, the data was screened for outliers and skewness, as well as to meet the assumptions for analysis of variance. When subjects had outlying scores on specific variables, their scores were moved inwards on the distribution of scores in the manner suggested by Tabachnick and Fidell (1989). Scores were altered by substituting the outlying score with a score that was one unit (e.g., one one-hundredth of a second) greater or smaller than the next most extreme score in the distribution. As no significant skewness was found, transformation of the data was not needed.

Data Analysis

Group analyses included a mixed factor analysis of variance of mean fixation scores in seconds. In the analysis of variance conducted for the Perception-Knowledge task there were four scores reflecting children's mean fixation in seconds to the correct and incorrect points in the visual access and no access conditions. If none of a child's trials were eliminated, then each of these four scores was based on the average looking time on two screens. In the analysis of variance for the Belief-Emotion task, there were also four scores representing children's mean fixations in seconds to the surprised and neutral faces in the expected and unexpected event conditions. If none of a child's surprise trials were eliminated, then each of these scores was based on the average looking time of two observations.

In order to assess group patterns in a slightly different way, against-chance analyses using paired *t*-tests were conducted comparing mean percent fixation to incongruent stimuli to a chance looking pattern, defined as 50%. In the Perception-Knowledge task, the incongruent stimuli included the images depicting an incorrect point in the visual access condition, and the images depicting a correct point in the no access condition. In the Belief-

Emotion task, the incongruent stimuli included the images showing surprised reactions in the expected event condition, and the images showing neutral reactions in the unexpected event condition.

Finally, individual analyses were undertaken to assess whether the pattern of results obtained in the group analyses were representative of the behaviour of individual children. Children were classified into one of three response categories, according to whether their mean percent fixation to incongruent stimuli was greater than chance (incongruency pattern), below chance (congruency pattern), or equal to chance (chance pattern). A child was considered to show a chance pattern of responding if his or her mean percent fixation to the incongruent stimuli was between 49.01% and 50.99%. Having classified children in this manner, we compared the distribution of children across two response categories (incongruent versus congruent and chance category combined) for the different age groups using a chi-square test for k samples. If the distributions did not differ as a function of age, then we collapsed across age and conducted a Goodness of Fit test in order to determine if the number of children showing an incongruency pattern versus either of the other response patterns combined was different from a hypothetical distribution, in which children were no more likely to be classified as having an incongruency pattern as one of the other patterns combined. The prediction was that more children would show an incongruency pattern.

Perception-Knowledge Task Results

Of the 103 children who completed the task, two were eliminated because of side biases, and 10 others because they did not produce enough valid data to allow computation of all scores. Therefore, the final sample for the Perception-Knowledge task consisted of 91 children (42 boys and 49 girls): thirty-two 18-month-olds, twenty-eight 24-month-olds, and thirty-one 30-month-olds. None of the children in the final sample had any hearing or visual problems as reported by their parents. Based on the trial elimination criteria outlined above, the percentage of trials eliminated in the Perception-Knowledge task was 14.84%, 8.93% and 6.45% for the 18-month, 24-month and 30-month-old samples, respectively. Of the final sample, 84 children sat in the infant seat for testing and seven sat on the parent's lap.

The prediction that infants' attributions of knowledge to another person would vary as a function of the perceptual experience of that person was tested by comparing visual fixation to the two test images (correct and incorrect pointing gestures) in the visual access and no access conditions. If toddlers understand the link between seeing and knowing in other people, they were expected to look longer at the incongruent test stimuli, which depicted a mismatch between perceptual access and knowledge of the object's location. Alternatively, if children egocentrically assume that others possess the knowledge that they themselves possess, then they were predicted to look longer at the incorrect point in both the visual access and the no access condition, since subjects themselves always knew the correct location of the hidden object.

To test these hypotheses, we conducted a Perceptual Condition (visual access versus no access) x Action (correct versus incorrect point) x Age (18, 24 and 30-month-olds) ANOVA. If children were able to link knowledge state to previous perceptual experience, then we expected a significant Perceptual Condition x Action interaction. In contrast, if children's tendency was to egocentrically attribute their <u>own</u> knowledge state to others, then they were expected to look longer at the incorrect point in both conditions, resulting in a main effect of Action.

A preliminary analysis revealed no interactions of gender with our variables of interest. Collapsing across gender, a 2 (Perceptual Condition) x 2 (Action) x 3 (Age) mixed factor ANOVA (Appendix F, Table F1) indicated a main effect of perceptual condition only, $F(1, 88) = 5.77$, $p < .05$. Across all ages, children's mean fixation to both test stimuli in the visual access condition ($M = 4.47$, $SD = .63$) was greater than in the no access condition ($M = 4.27$, $SD = .69$. No other effects were significant. Contrary to our predictions, then, there was not a significant interaction of the perceptual condition and action conditions (see Figure 1), suggesting that children failed to consider the protagonist's previous perceptual experience when shown pictures of that person either accurately or inaccurately identifying an object's location. Moreover, children did not appear to attribute their own knowledge state to the protagonist, given that longer fixations to the incorrect actions were not sufficiently widespread to create a main effect of action.

Against-chance comparisons were conducted to determine whether mean percent fixations to the incongruent stimuli (visual access-incorrect point, and no access-correct point) were significantly greater than chance. These predictions were tested using one-tailed paired t-tests, with a Bonferonni correction. The against-chance comparisons also failed to support our predictions. For all three age groups, mean fixation to the incongruent stimulus was not significantly greater than chance in the visual access condition or in the no access condition (t values ranged from -2.07 to 1.89, $p > .025$). In the visual access condition, mean percent fixation to the incongruent stimuli for the 18-, 24-, and 30-month-olds was 53.98% ($SD = 11.88$), 46.61% ($SD = 8.66$), and 50.46% ($SD = 8.72$), respectively. In the no access condition,

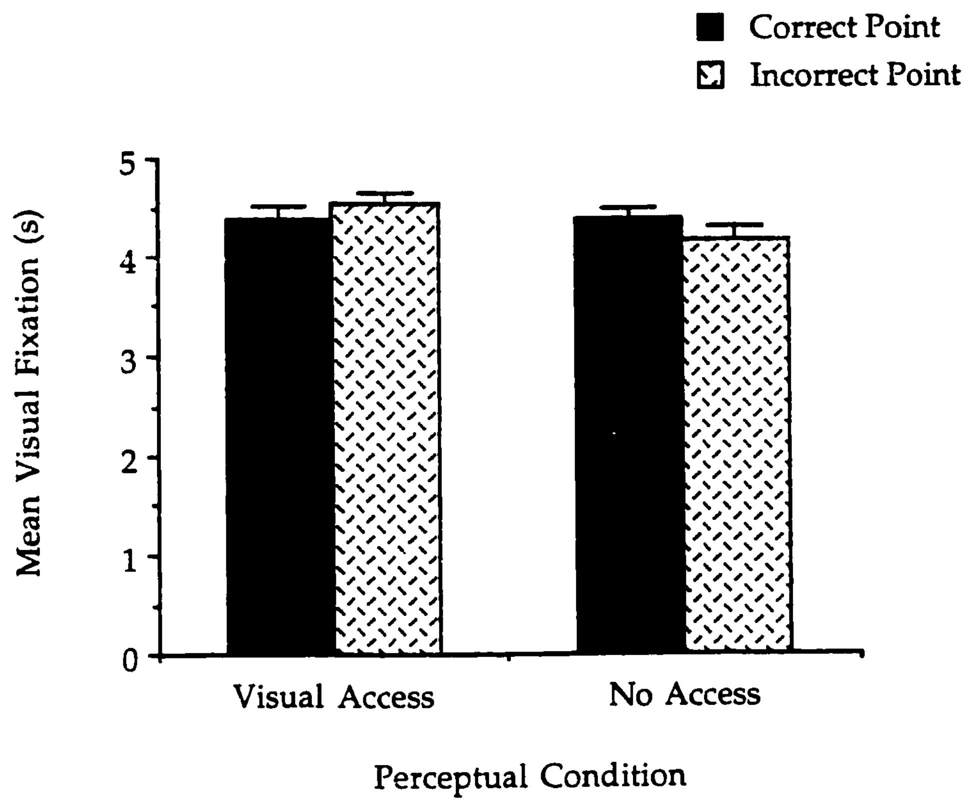


Figure 1. Mean Visual Fixation as a Function of Perceptual Condition and Action.

mean percent fixation to the incongruent stimuli for the 18-, 24-, and 30-month-olds was 51.90% (SD = 9.25), 52.71% (SD = 12.94), and 50.55% (SD = 8.94), respectively. These results were consistent with the results of the ANOVA.

Finally, we conducted an analysis of individual children to determine whether some children showed the predicted incongruency pattern of responding. Regardless of condition, the number of children classified as incongruency responders versus congruency and chance responders combined did not vary as a function of age, X^2 (2, N = 91) = 1.29, p > .05, and X^2 (2, N = 91) = 3.83, p > .05 for the no access and visual access conditions, respectively. Collapsing across age in the no access condition, the number of children falling in each response category were as follows: incongruency pattern (n = 50), congruency pattern (n = 35), and chance pattern (n = 6). Collapsing across age in the visual access condition, the number of children falling in each response category was as follows: incongruency pattern (n = 43), congruency pattern (n = 41), and chance pattern (n = 7). Despite the apparent predominance of incongruency responders in the no access condition, the difference in the number of children showing an incongruency pattern versus one of the other patterns for this condition was not significant, X^2 (1, N = 91) = 0.89, p > .05. In the visual access condition as well, there was not a significant difference in the number of children classified in these two response categories, X^2 (1, N = 91) = 0.28, p > .05.

Belief-Emotion Task Results

Of the 103 children who completed the task, two were eliminated because of side biases, and nine others because they did not produce enough valid data to allow computation of all scores. Therefore, the final sample for the Belief-Emotion task consisted of 92 children (43 boys and 49 girls): twenty-nine 18-month-olds, thirty-one 24-month-olds, and thirty-two 30-month-olds. None of these children had any hearing or visual problems as reported by their parents. Based on the trial elimination criteria outlined above, the percentage of trials eliminated in the Belief-Emotion task was 7.76%, 5.65%, and 3.13% for the 18-month, 24-month and 30-month samples, respectively. Eight children sat on the parent's lap for testing, and the remaining 84 children accepted the infant seat.

The purpose of this task was to test whether infants recognize that surprised reactions occur when what a person knows or believes to be true turns out to be untrue. If infants understand the relationship between beliefs and emotions, then they may be perplexed when a person fails to display surprise following an unexpected event, or when a person expresses surprise in the context of an expected event. To test these ideas, we conducted an Emotion (surprised versus neutral) x Event Type (expected versus unexpected) x Age (18-, 24-, and 30-month-olds) analysis of variance. If young children understand that surprised reactions occur in response to belief violations, then an emotion x event type interaction in the incongruent direction was anticipated. That is, we predicted longer fixations when a mismatch occurred between the actor's emotional reaction and the type of event she had witnessed (i.e., the surprised face on expected event trials, and the neutral face on unexpected event trials). No interactions involving gender were anticipated.

A preliminary analysis of variance revealed no interactions of gender with the variables of interest. Collapsing across gender, a 2 (Emotion) x 2 (Event Type) x 3 (Age) mixed factor ANOVA yielded main effects of group, F (2, 89) = 3.13, $p < .05$, emotion, F (1, 89) = 93.88, $p < .01$, and event type, F (1, 89)

$= 31.77$, $p < .01$, and additionally a significant group x emotion interaction, F $(2, 89) = 8.52$, $p < .01$ (Appendix F, Table F2). The main effect of event type reflected greater mean fixation times on expected event trials ($M = 4.60$, $SD = .53$) than on unexpected event trials ($M = 4.24$, $SD = .79$). The group x emotion interaction was explored with correlated t-tests by comparing visual fixation to the surprised and neutral expressions within each of the three age group separately. These tests revealed an ordinal interaction. While children in the 18, 24, and 30 month samples all looked longer at the surprised faces than at the neutral faces, ($t(28) = -7.65$, $p < .01$, $t(30) = -4.92$, $p < .01$, and $t(31) = -3.53$, $p < .01$, respectively), this tendency diminished with age as reflected by the differences in the means over time (see Figure 2).

With regard to percentage scores, we expected mean looking times to each of the incongruent stimuli (surprised face - expected event and neutral face - unexpected event) to exceed chance. This prediction was tested using one-tailed paired t-tests with a Bonferonni correction. In the expected event condition, mean percent fixation to the incongruent stimulus (surprised face) was significantly above chance for the 18-month-olds ($M = 61.19\%$, $SD = 10.09$, $t(28) = 5.97$, $p < .01$), 24-month-olds ($M = 56.56\%$, $SD = 9.82$, $t(30) = 3.72$, $p < .01$), and 30-month-olds ($M = 54.63\%$, $SD = 7.40$, $t(31) = 3.54$, $p < .01$). While this is consistent with the prediction of an incongruency effect, such an effect was not found in the unexpected event condition, where we had predicted longer looking times to the neutral face. Contrary to prediction, mean percent fixation to the neutral face in the unexpected event condition was found to be significantly below chance in the 18- ($M = 38.83\%$, $SD = 11.81$, $t(28) = -5.10$, $p < .01$) and 24-month-old ($M = 44.53\%$, $SD = 7.56$, $t(28) = -4.02$, $p < .01$) age groups. Thirty-month-olds also failed to perform in the predicted manner in the unexpected condition, where their mean fixation to the

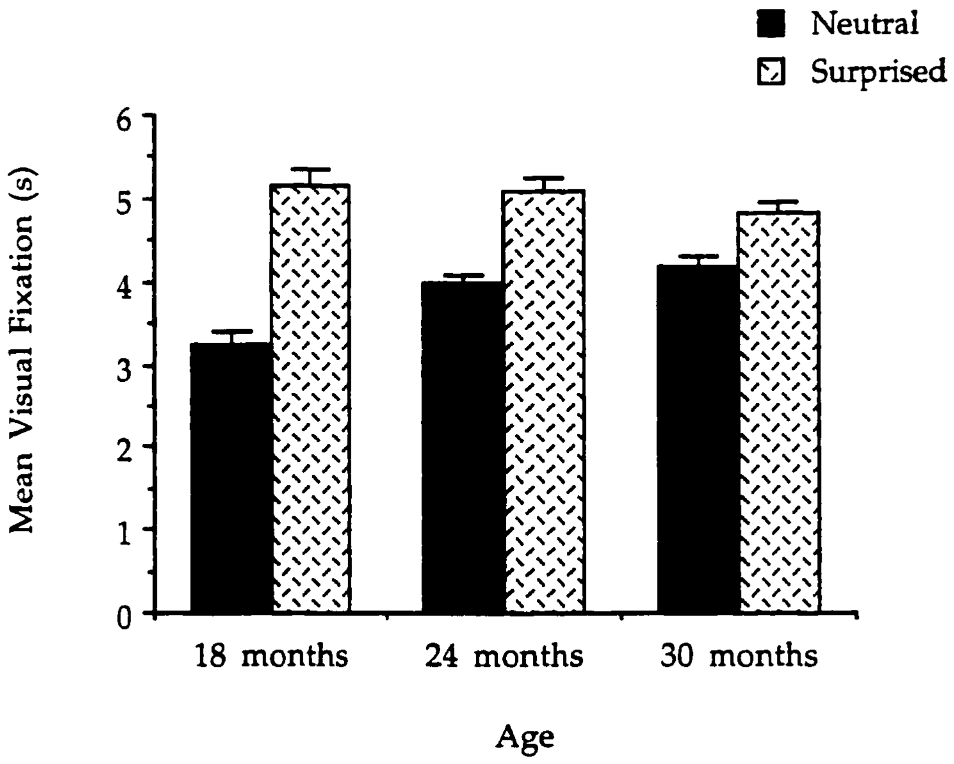


Figure 2. Mean Visual Fixation to the Surprised and Neutral Faces as a Function of Age

incongruent stimulus (neutral face) was not different from chance ($\underline{M}$ = 47.99%, $\underline{SD}$ = 8.49, $\underline{t}(31) = -1.34$, $\underline{p} > .05$). In summary, the against-chance comparisons using percentage scores suggested a preference for the surprised face regardless of event type.

Given the clear salience of the surprised face for children in this task, we altered our previous approach for classifying individual children's response patterns. Rather than comparing a child's percent visual fixation to incongruent stimuli against chance looking, we directly compared their mean percent fixation times to the surprised face in the two event type conditions (expected versus unexpected event). To this end, a difference score was computed by subtracting a child's mean percent fixation to the surprised face in the unexpected event condition from his mean percent fixation to the surprised face in the expected event condition. We predicted that children would demonstrate longer percent fixations to the surprised face in the context of expected events than in the context of unexpected events, where surprised reactions typically occur, thereby obtaining positive difference scores. For each of the age groups tested, individual children were classified according to whether their difference score was 1 or greater than 1 (incongruency pattern), -1 or less (congruency pattern), or equal to zero (chance pattern). We predicted that incongruency responders would outnumber children falling in the other response categories combined.

An overall Chi Square test for k samples was used to compare the distribution of children across the two response categories (incongruency versus congruency and chance pattern combined). This test was not significant, indicating that the distribution of children across the two response categories did not vary as a function of age, X^2 (2, $\underline{N}$ = 92) = 1.34, $\underline{p} > .05$. Collapsing across age, the number of children showing the various response patterns were: incongruency pattern ($\underline{n}$ = 52), congruency pattern ($\underline{n}$ = 38), and chance pattern ($\underline{n}$ = 2). A goodness of fit test for one sample failed to find a significant difference in the frequency of children falling in the two response categories, $X^2(1, \underline{N} = 92) = 1.57$, $\underline{p} > .05$. Thus, children did not seem perplexed when surprised reactions occured in the context of an expected event.

Discussion

Perception-Knowledge Task

The purpose of the Perception-Knowledge task was to assess young children's understanding that knowledge may be acquired by means of visual perception. Overall, we obtained no support for this kind of understanding in children aged 18 to 30 months. While analysis of individual subjects suggested a small tendency for children to look longer when the protagonist appeared knowledgeable in the no access condition, significant findings were not obtained. The failure of 30-month-old children on the Perception-Knowledge task was not anticipated, since an unpublished study previously demonstrated an understanding of the perception-knowledge relationship in children with a mean age of 31 months (e.g., Pillow & Brownell, 1991). One explanation for the discrepancy between our results and Pillow and Brownell's is that young children may demonstrate greater sensitivity to others' knowledge states in social situations than in the context of relatively nonsocial tasks such as the preferential looking task. As Pillow and Brownell noted, children in their study were placed in a situation where they had a motive for considering the other's knowledge state, something that children in our study lacked. On the other hand, children have demonstrated several early competencies by means of visual paradigms similar to ours, with no apparent motive other than their own interest and natural tendency to try to make sense of the world around them (e.g., Spelke, 1985).

Another possible account of task failure concerns the specific attentional measures selected. As discussed elsewhere, the preferential looking paradigm allows for a variety of dependent variables (Schafer & Plunkett, 1998). In this study, we elected to measure total looking time at the test images expressed in absolute terms and in proportional terms, as these are known to be reliable measures (e.g., Naigles & Kako, 1993; Reznick, 1990). Other candidate measures that might be explored include duration of the child's first look at each test stimulus, and duration of longest look at each test image. In studies employing multiple measures, these alternative measures have sometimes proven more sensitive than total looking time (e.g., Schafer & Plunkett, 1998). One explanation for the greater sensitivity of a measure like longest look is that it is less subject to the potential error associated with the coding of many rapid glances. Nonetheless, intercoder reliability in the present study was very good, suggesting that the error related to this factor was minimal. Furthermore, the validity of cumulative fixation measure is believed to decrease towards the end of trials (Schafer & Plunkett, 1998). To the extent that our subjects "tuned out" towards the end of test phases and started to respond randomly, it is possible that the 10-second long test phase of trials was too long to detect a difference in looking times to the two screens.

Finally, it is possible that while children in this age range understand the association between visual perception and knowing, they were not able to demonstrate this knowledge due to the memory demands of the task. In order to succeed on this task, children had to hold several pieces of information in mind at once. They needed to remember both the location of the hidden toy and whether the person had had visual access to the toy's location. As such, it is possible that children either forgot the location of the hidden toy or the person's perceptual experience, or both. As we did not include a memory control condition, we cannot conclude with certainty that memory problems contributed to children's failure on the task, but this remains a possibility.

Belief-Emotion Task

The purpose of the Belief-Emotion task was to assess young children's understanding that surprised reactions occur when a person's knowledge or expectation about the world is violated. Overall, the results of the Belief-Emotion task failed to demonstrate a belief-based understanding of surprised reactions in children aged 18 to 30 months. This is not remarkable, given that no previous study has shown an understanding of a belief-dependent emotion before three years of age. However, we did anticipate that with a simple methodology in which children were not required to respond verbally that there was some possibility that at least 30-month-olds would solve the task. Assuming that toddlers do understand how surprised reactions relate to a person's prior mental state, their failure on the present task may have been due to a number of methodological factors.

Without question, the salience of the surprised face constituted an important problem. In order to obtain the predicted interaction of emotion and event type, children needed to show differential attention to the surprised face, depending on the event condition. This shift in looking required that the child not be biased to the surprised face, which unfortunately was not the case. The salience of the surprised expression was unexpected, particularly in light of the finding that surprised expressions (at least mock surprise) are displayed by mothers quite frequently in the context of mother-infant interactions (Malatesta & Haviland, 1982). Nevertheless, at least one other study obtained a similar salience effect of surprised faces (Serrano, Iglesias, & Loeches, 1992). In the latter study, which aimed to test whether 4- to 6-month-old infants could recognize and discriminate facial expressions of anger, fear and surprise, infants spent more time looking at expressions of surprise and anger than at expressions of fear. This suggests that the preference for surprised faces observed in the present study may be observed in relation to other expressions in addition to neutral expressions, and may be present in infants as young as 4 months of age.

Another possible account of children's failure on the Belief-Emotion task is that the children were unable to infer the story protagonist's knowledge state (i.e., knowledge or ignorance of the object's location) on the basis of information provided because they lack an understanding of the perception-knowledge relationship. Recall that children were required to infer the protagonist's knowledge state from information about perceptual access. If they failed to do so, then attention to the surprised and neutral faces would not be expected to vary with event type, since infants did not interpret the events in the manner in which they were intended. In order to address this issue in future studies, one might present children with more direct information about a protagonist's mental state, rather than requiring them to infer such states. For instance, the story protagonist's knowledge state might have been revealed using verbal cues alone, or through other nonverbal cues. Finally, as in the case of the Perception-Knowledge study, task failure may be explained in part by the use of total looking measures, rather than some other more sensitive measure of attention such as longest look.

CHAPTER THREE: DESIRE AND DESIRE FOLLOW-UP EXPERIMENTS

Experiment 2: Desire Experiment

The purpose of Experiment 2 was to explore the understanding of desire-dependent action and desire-dependent emotion in 18- to 30-month-old children. In order to evaluate these aspects of children's knowledge of the mind, two tasks were designed: the Desire-Action task and the Desire-Emotion task. Concerning children's understanding that desires guide actions, one previous interview study using an action-prediction method has demonstrated an understanding of desire-based action in 2 1/2-year-olds (Wellman & Woolley, 1990). In addition, 2-year-olds commonly refer to desires when explaining people's actions in the context of everyday conversations (Bartsch & Wellman, 1995). With regard to the abilities of even younger children, one habituation study found that 12-month-old infants can predict future actions based on behavioral cues (gaze direction and emotional expression) about what a person desires (Spelke, Phillips, & Woodward, 1995). In the Desire-Action task of the present study, information about the protagonist's desire was conveyed through visual and verbal cues only, <u>without</u> any accompanying emotional information. Thus, we aimed to test whether infants can predict a person's actions on the basis of attentional and verbal cues alone. It was predicted that children as young as 18 months would demonstrate an understanding of the relationship between desires (or attention) and human actions.

With regard to children's knowledge that desires shape emotions, such as happy and sad reactions, previous research based on verbal interviews suggests that children as young as 2 1/2 years can make use of desire information to predict happy and sad reactions to desire-relevant outcomes

(Wellman & Woolley, 1990). Concerning the ability of younger children, one study found some knowledge of the relationship between desires and emotions at 18-months, but not at 14 months of age (Repacholi & Gopnik, 1997). However, food preferences were the only desires investigated, and pleased and disgusted reactions the only emotions used in this study, making the generalizability of the findings to other desires and emotions uncertain. Moreover, the latter study demonstrated understanding that desires may be inferred from emotional cues, not the understanding that emotional reactions may depend on desires in combination with outcomes. The Desire-Emotion task of Experiment 2 aimed to further investigate infants' understanding of the relationship between desires and emotions by focusing on desires for non-food items, and by assessing understanding of happy and sad emotional reactions to various desire-relevant outcomes. Although our primary interest was in the performance of 18- and 24-month-olds on both tasks, a 30-month-old sample was included in order to evaluate the sensitivity of our methodology. Given that 2 1/2-year-olds have succeeded on verbal tasks assessing desire-dependent action and desire-dependent emotion, they were expected to pass our mainly nonverbal task without difficulty.

Method

Participants

Ninety-five English-speaking children participated. Children were recruited from birth lists obtained from the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre after approval by the Commission d'Accès à l'Information du Québec. Of the original sample, three 18-month-old children were eliminated because of crying or fussiness. Demographic data were computed on the remaining 92 children for the 3 age groups separately. The mean age of participants in the 18-, 24-, and 30-month samples was 18.44 months (SD = .45), 24.57 months (SD = .58), and 29.82 months (SD = .57), respectively. Children's socioeconomic status was estimated using occupational ratings of the Blishen, Carroll and Moore (1981) index (M = 42.74, SD = 13.28). Children were assigned a single socioeconomic status (SES) score that corresponded to the highest occupational score obtained by either parent. Mean socioeconomic scores in the 18-, 24-, and 30-month samples were 62.19 (SD = 21.79), 59.45 (SD = 16.96), and 55.84 (SD = 19.83), respectively. The fact that SES scores varied only slightly as a function of age group suggests that children in the different age groups were from similar socioeconomic backgrounds.

Apparatus

Infants were tested using the same adaptation of the preferential looking technique as described in Experiment 1. The child was seated in a booster seat or clip-on chair attached to a table, or if necessary in the parent's lap. Specifications regarding distance from the screen, etc., were identical to those in Experiment 1. During the testing session, the experimenter stood behind the curtain where she was not visible to the child, and operated the camcorder.

Stimuli

Two series of videotaped vignettes were developed. The first series was used in the Desire-Action task and consisted of six trials (4 standard trials and 2 control trials). The control trials of the Desire-Action task and the Desire-Emotion task were included to help rule out a potential confound involving object preferences. Trials had the same structure as trials in

Experiment 1, and included an information phase and a test phase interspersed by a brief pause. During the information phase, which was displayed on only one of the television monitors, children were given information about the story protagonist's desire. The information phase was always followed by a test phase that commenced with the onset of two still images intended to constitute two different endings (congruent and incongruent) to the story depicted in the information phase. The duration of the information phase varied slightly from trial to trial, ranging from 19 to 22 seconds in the Desire-Action task, and from 14 to 17 seconds in the Desire-Emotion task. Test phases were all 8 seconds in duration, and an interval of 0.66 seconds occurred between the two phases to encourage looking at both screens during the test phase. A 3-second pause during which both screens showed a solid black background occurred between trials. For each trial, three brief tones were delivered through the central speaker. The first tone occurred just prior to the information phase and was intended to orient children to the visual displays. The second and third tones were presented simultaneous with the onset and the end of the test phase. The latter tones let coders know when to begin and when to stop recording children's visual fixations for the test phase.

In the Desire-Action task, the information phase always began with an actress seated at a table supporting two objects at the outer corners (e.g., apple and banana) (See Appendix G for a schematic representation of the stimuli used in Experiment 2). For the four standard trials, the pair of objects on the table was different on each trial, so as to maintain infants' interest and to eliminate ambiguity about which object the actor desired on a given trial. On the two control trials, which were always administered at the end of the experiment, the object pairs appearing on the table matched those used in two of the four standard trials. However, in the control trials the desired and nondesired object were the reverse to what they had been in the standard task.

At the beginning of trials, the videotaped actress greeted the subject, and then looked at and labelled each of the objects on the table in turn (e.g., "Hi baby! Let's see what's on the table. I see an apple and I see a banana."). This was done in an effort to focus infants' attention on both objects. The actress then expressed her desire for a specific object by gazing and pointing at it while saying, "I want that one! I want that one!" Thus, subjects were given both verbal and nonverbal (point and gaze) cues about the actress' desire. The information phase ended with the actress putting her hands on her lap under the table. Following a 0.66-second pause during which both screens were blank, the test phase began. In the test phase, infants viewed a still frame image of the actress grasping the desired object on one screen, referred to as the congruent action, and a second image of the actress grasping the nondesired object on the other screen, referred to as the incongruent action.

We predicted that children would demonstrate longer fixations to the incongruent actions, reflecting an understanding that people's actions are guided by their desires. However, one concern was that a child's fixation times to the two images presented during the test phase might be influenced by a child's preference for specific objects. For example, if children looked longer at the image of the actress grasping a banana, when moments before she had expressed a desire for an apple, this might reflect a mere preference for looking at bananas, rather than an understanding that people's actions are usually consistent with their desires. While it was unlikely that a child would have preferences on all the standard trials and that these would happen to coincide with the incongruent stimuli for all 4 trials, we decided to include the control trials in order to evaluate fixation at incongruent actions without the potentially confounding effect of object preferences.

A second series of trials was developed for the Desire-Emotion task, consisting of four standard and two control trials. Again, the videotaped stories included an information phase and a test phase lasting eight seconds. During the information phase, subjects viewed two actors sitting at a table, a female protagonist (Actor 1) and a male actor (Actor 2) who had two objects in front of him (See Appendix G, for a schematic representation of the stimuli used in this task). For the four standard trials, the pair of objects held by the male actor was different on each trial, so as to maintain infants' interest, and to eliminate possible ambiguity about which object the protagonist desired on a given trial. On the two control trials, which were always administered at the end of the experiment, object pairs matched those used in two of the four standard trials. However, in the control trials the desired and nondesired object were the reverse to what they had been in the standard task.

In the Desire-Emotion task, information phases began with Actor 2 holding up each of two objects in turn and labelling them for the protagonist (e.g., "See what I have? I have a cup, and I have a bowl."). Again, this was done to familiarize infants with both objects. The protagonist then expressed a desire for a specific object by pointing to it and saying "I want that one! I want that one!" At this juncture, Actor 2 either gave the actress what she wanted, referred to as the positive outcome trials, or gave her the nondesired object, referred to as negative outcome trials. The information phase ended once the protagonist had been given either the desired or nondesired object.

During the test phase, subjects saw a still frame image of the protagonist holding the object she had been given with a happy facial expression on one monitor, and a second image of her holding the same object while displaying a sad facial expression on the other monitor. Thus, on both positive and negative outcome trials, one of the screens showed the actress reacting in a predictable way to the outcome, referred to as the congruent stimulus, while the second screen showed her reacting in an anomalous way, referred to as the incongruent stimulus. For example, on trials where the actress was given the object she desired, the screen depicting the happy face was considered the congruent stimulus, and the screen depicting the sad face was considered the incongruent stimulus, since we expect people to be happy and not sad when their desires are satisfied.

In order to ensure that the emotional expressions presented to infants were good exemplars of the emotion in question, independent ratings were gathered from 15 adult subjects (6 males and 9 female, M = 23.6) who were tested in small groups. See Appendix C for the consent form, instructions and response sheet provided to the adult raters. In order to obtain these ratings, six emotional expressions (2 from each experiment) were displayed one at a time on a single television monitor. Expressions were presented in the following fixed order: happy, sad, neutral, surprised, happy, sad. Upon the presentation of each expression, raters were asked to select one of 7 emotion labels (happy, sad, surprised, disgusted, fearful, angry, or neutral) to match the expression displayed. When presented with the happy and sad expressions used in the Desire-Emotion task of Experiment 2, all 15 of the adult raters successfully identified the happy expression. The great majority of adults viewers (13 out of 15 subjects) also selected the correct label for the sad face. Thus the facial expressions presented in the Desire-Emotion task appear to have been very good examples of happy and sad expressions.

The purpose of the control trials in the Desire-Emotion task was to examine whether children's success on the task might be influenced by their own preferences for specific objects. If a child had object preferences, he or she was expected to succeed on trials in which the protagonist's desire coincided with the child's own, but to fail on trials where the protagonist's desire was different from the child's own. Thus, a child with an object preference was expected to consistently look at the emotional reaction that conflicted with his own object preference, regardless of the protagonist's desire on that trial. For example, on trials in which the protagonist was shown a cup-bowl pair, if a child preferred the cup, he was expected to look longer at the test image showing a happy reaction to the bowl. If children behaved in this manner, they would be inclined to look at the congruent expression on half the trials and at the incongruent expression on the remaining trials, leading to null results. Because null findings are open to other interpretations, such as chance responding, they do not prove the existence of object preferences, but are consistent with their presence.

Design and Procedure

The entire experiment consisted of 12 trials, including the four desire-action standard trials, the four desire-emotion standard trials, and the four control trials. The design of Experiment 2 is presented in Table 2. Children were administered all 12 trials in one of two fixed orders (see Appendix H). Half of the participants in each age group were administered Order 1 and the remaining half received Order 2. Both orders were designed such that subjects viewed the standard trials of both tasks ($\underline{n}$ = 8) prior to viewing the control trials ($\underline{n}$ = 4). This was done to maintain infants interest and to avoid giving infants conflicting information about the actors' desires. The difference between the orders was that in one order, the trials comprising the

Table 2

Design of Experiment 2

Desire Action Standard Trials

Trial	Object pair	Test screen 1	Test screen 2
1	**flower**/clock	reach flower	reach clock (i)
2	banana/**apple**	reach banana (i)	reach apple
3	**shoe**/hat	reach hat (i)	reach shoe
4	bottle/**glasses**	reach glasses	reach bottle (i)

Desire Emotion Standard Trials

Trial	Object pair	Outcome	Test screen 1	Test screen 2
5	**brush**/soap	positive	happy - brush	sad - brush (i)
6	**fork**/spoon	negative	happy - spoon (i)	sad - spoon
7	red/**green**	positive	sad - green (i)	happy - green
8	**cup**/bowl	negative	sad - bowl	happy - bowl (i)

Desire Action Control Trials for Trials 1 and 2

Trial	Object pair	Test screen 1	Test screen 2
9	**banana**/apple	reach banana	reach apple (i)
10	flower/**clock**	reach flower (i)	reach clock

Desire Emotion Control Trials for Trials 7 and 8

Trial	Object pair	Outcome	Test screen 1	Test screen 2
11	cup/**bowl**	positive	sad - bowl (i)	happy - bowl
12	**red**/green	negative	sad - green	happy - green (i)

Note. Bolded items represent the objects desired by the protagonist. i=incongruent stimulus.

the Desire-Action task were presented first, whereas in the other, the trials of the Desire-Emotion task were administered first.

Appropriate counterbalancing was done for both tasks. For both the Desire-Action and the Desire-Emotion task (standard and control trials), the side of presentation of the information phase was counterbalanced, such that the information phase occurred on the left monitor for half the trials and on the right monitor for the remaining trials. This was done to prevent children from developing side biases. In addition, trials were designed in such a way that the incongruent test stimulus was presented on the same screen as the preceding information phase on only half of the trials. This was done to rule out interpretations of task success in terms of an infant bias for the monitor displaying the information phase. Finally, the screen (left versus right) on which the congruent and incongruent stimuli were presented during the test phase was counterbalanced across trials. Thus in the Desire-Action task, the incongruent action was presented on the left screen for half the trials and on the right screen for the remaining trials.

Similar counterbalancing was done for the Desire-Emotion task. In this task, the screen (left versus right) on which the happy and sad faces were presented was counterbalanced, such that a particular facial expression (e.g., sad) occurred on the right monitor for half the trials and on the left monitor for the remaining trials. Similarly, incongruent stimuli (e.g., positive outcome - sad face) appeared on the left screen for half the trials and on the right screen for the remaining trials. The relative locations of the desired and nondesired object on the table were also counterbalanced, so the desired object was the one closest to the protagonist on half the trials and the one furthest from her on the remaining trials. Furthermore, on half the trials the actress' desire was satisfied (positive outcome) and on half the trials her desire was thwarted (negative outcome). The procedure was identical to that used in Experiment 1.

Results

Interobserver Agreement

For both tasks, two observers who were blind to the position of the congruent and incongruent screens recorded mean looking times at the right and left screens during the test phase across all trials for a randomly selected 20% of the subjects. Interobserver reliability was assessed using a Pearson's product-moment correlation between the two observers' ratings for the Desire-Action and Desire-Emotion tasks separately. Two correlation coefficients were obtained for each task (i.e., time on the right screen and time on the left screen) and were then averaged. Mean interobserver reliability was $r = .958$ for the Desire-Action task and $r = .939$ for the Desire-Emotion task.

Data Screening

Data screening procedures were the same as those used in the Experiments 1. Cumulative visual fixation time in seconds to the left and right test screens and to the active screen during the information phase were recorded for each trial. In addition, the proportion of fixation time to each test screen out of total on-screen time was computed. Based on these two sets of data, a total of 20 scores were computed for the entire experiment (eight scores for the Desire-Action task and 12 scores for the Desire-Emotion task). For the Desire-Action task (standard and control analyses), the dependent variables were mean looking times (in seconds and percent) to the incongruent and congruent actions. In the Desire-Emotion task (standard and control analyses), dependent variables were mean looking times (in seconds and percent) to the happy and sad expressions in the positive and negative outcomes conditions.

Prior to data screening, trials and subjects were eliminated from the analysis in accordance with the same criteria described in Experiment 1. Trials were eliminated if (a) cumulative visual fixation to the target screen during the information phase amounted to less than 80% of the information phase duration for that trial, (b) total visual fixation to both screens combined during the test phase was less than 25% of the total test phase duration, or if (c) visual fixation to one of the test screens was zero. Subjects were eliminated from all analyses on the basis of the following criteria: a) if they exhibited a side bias, defined as looking 65% or longer at either screen (left or right) across all twelve trials of the experiment, or (b) if the subject lacked the data necessary to compute all dependent variables in a given task. Data were then screened for outliers and skewness, as well as to meet the assumptions for analysis of variance. There was no significant skewness found, so transformation of the data was not needed.

Data Analysis

For both the Desire-Action and the Desire-Emotion task, two types of analyses were conducted. One set of analyses involved the four standard trials only, while the other set involved the two control trials and the two standard trials employing matching object pairs. For the purpose of this report, I will refer to these two sets of analyses as the analysis of standard trials and the analysis of control trials, respectively.

Group analyses included mixed factor analyses of variance using raw scores (i.e., mean fixation to test stimuli in seconds). Because children virtually always had some off-screen time during the test phase, fixation times to the two test screens were considered independent of one another. In the Desire-Action task (standard and control analyses) there were two scores reflecting children's mean fixation in seconds to the congruent and incongruent actions. If no trials were eliminated, then each of these means was based on four trials. In the Desire-Emotion task (standard and control analyses), there were four scores representing children's mean total looking time in seconds to the happy and sad faces in the positive and negative outcome conditions. If none of a child's desire-emotion trials was eliminated, then each of these means was based on two trials.

In order to assess group patterns in a different way, against-chance analyses using t-tests were conducted, comparing percent looking at incongruent stimuli to chance looking, defined as 50% looking to each screen. Percentage scores represented the proportion of time a child looked at the incongruent test stimulus out of total onscreen time during the test phase. In the Desire-Action task (standard and control analyses), one score was computed, reflecting percent fixation to incongruent actions, (i.e., grasping the nondesired object). In the Desire-Emotion task (standard and control analyses) two scores were computed, reflecting mean percent fixation to the sad face in the positive outcome condition, and mean percent fixation to the happy face in the negative outcome condition. For both tasks, it was predicted that percent fixation to the incongruent stimuli would be significantly greater than chance.

Finally, individual analyses were carried out to assess whether the pattern of results obtained in the group analyses were representative of the group as a whole. Children were classified into one of three response categories, according to whether their mean percent fixation to incongruent stimuli was greater than chance (incongruency pattern), below chance (congruency pattern), or equal to chance (chance pattern). Percentage scores were the same as those used in the against-chance comparisons conducted on the whole sample. Having classified children in this manner, we compared the number of children showing an incongruency pattern to the number of children showing either of the other response patterns using a chi-square goodness of fit test. Predictions were that incongruency responders would outnumber children showing either of the other response patterns combined.

Desire-Action Task Results: Analysis of Standard Trials

Of the 92 children who completed the task, two were eliminated because of side biases, and two others because they did not produce enough valid data to allow computation of all scores. Therefore, the final sample for the Desire-Action task (standard trials) consisted of 88 children (44 boys and 44 girls): twenty-nine 18-month-olds, twenty-nine 24-month-olds, and thirty 30-month-olds. None of the children in the final sample had any hearing or visual problems as reported by the parents. For the final sample, the percentage of trials eliminated according to the criteria outlined above was 14.66%, 11.21% and 6.67% for the 18-month, 24-month and 30-month samples, respectively.

A preliminary analysis revealed no significant effects involving order or gender. Collapsing across these variables, a 2 (Action) x 3 (Group) mixed factor ANOVA using mean looking times was conducted (see Appendix I, Table I1). If infants understand that desires guide actions, they were expected to look longer at the incongruent actions, resulting in a main effect of action in the incongruent direction. As shown in Figure 3, there was indeed a significant main effect of action, $F(1, 85) = 27.64$, $p < .01$, owing to the fact that

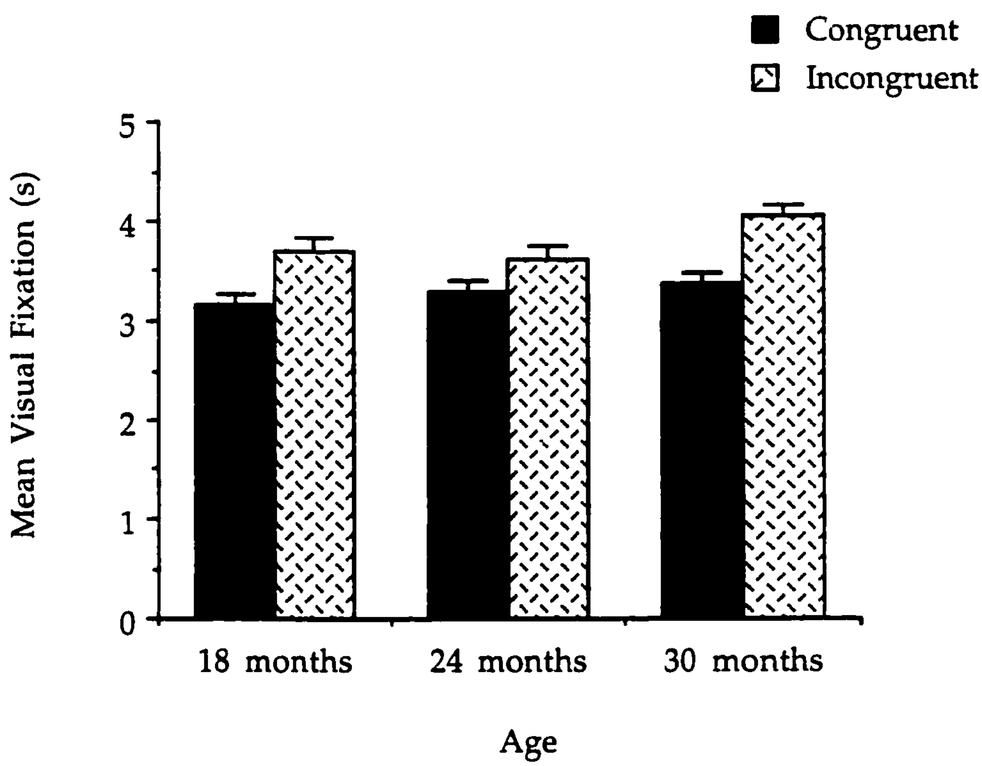


Figure 3. Mean Visual Fixation to Congruent and Incongruent Actions as a Function of Age

infants in all age groups looked longer at the incongruent actions ($\underline{M}$ = 3.80, $\underline{SD}$ = .73) than at the congruent actions ($\underline{M}$ = 3.28, $\underline{SD}$ = .56). In addition, there was a significant main effect of group, $\underline{F}$ (2, 85) = 3.95, $\underline{p}$ < .05. A Tukey test was conducted to examine the group main effect. This test failed to show a significant difference in looking times across ages; however, 30-month-olds appeared to have somewhat longer mean looking times than children in the younger age groups, possibly reflecting maturational increases in attention.

Against-chance comparisons revealed a similar pattern of results to that found in the analysis of variance. Consistent with our predictions, mean percent fixation to the incongruent actions was significantly above chance in the 18-month ($\underline{M}$ = 53.79%, $\underline{SD}$ = 6.46, $\underline{t}$(28) = 3.16, $\underline{p}$ < .01), 24-month ($\underline{M}$ = 52.24%, $\underline{SD}$ = 6.54, $\underline{t}$(28) = 1.85, $\underline{p}$ < .05), and 30-month samples ($\underline{M}$ = 54.31%, $\underline{SD}$ = 5.63, $\underline{t}$(29) = 4.19, $\underline{p}$ < .01), again suggesting an early understanding that desires guide actions.

When individual subject patterns were examined, findings were again in line with our predictions. For each age group, individual children were classified according to whether mean percent fixation to the incongruent stimuli was greater than chance, less than chance, or equal to chance. A child was classified as showing an incongruency pattern if his or her mean visual fixation to the incongruent actions was at least 51.00%. A Chi Square test for k samples was used to compare the distribution of children across the two response categories (incongruency pattern versus congruency and chance pattern combined). This test was not significant, suggesting that the distribution of children across the two response categories did not vary as a function of age, X^2 (2, $\underline{N}$ = 88) = 1.47, $\underline{p}$ > .05. Therefore, we collapsed across age and conducted a Goodness of Fit test to determine whether incongruency responders predominated. Consistent with our predictions, significantly more children were found to show an incongruency pattern (n = 56) than a congruency (n = 19) or chance pattern (n = 13) combined, $X^2(1, N = 88) = 6.55$ $p < .05$.

Desire-Action Task Results: Analysis of Control Trials

Of the ninety-two children who completed the task, two children were eliminated because of side biases. An additional 18 children were eliminated because they failed to produce sufficient data to allow for the computation of all scores. The final sample consisted of 72 children (37 girls and 35 boys): twenty-three 18-month-olds, twenty-one 24-month-olds, and twenty-eight 30-month-olds. For the final sample, the percentage of trials eliminated was 26.09%, 8.33% and 6.25% for the 18-month, 24-month and 30-month samples, respectively.

A 2 (Action) x 2 (Gender) x 2 (Order) x 3 (Group) analysis of variance was conducted in order to assess children's performance on trials (standard and control) in which the object pairs used were held constant. If many of children's responses were being driven by object preferences, then a main effect of action type would not be possible, since a preference for a particular item in an object pair would lead a child to look at the congruent screen on one trial and at the incongruent screen on the corresponding trial, resulting in null results.

A preliminary analysis revealed no significant effects involving order. Collapsing across this variable, a 2 (Action) x 2 (Gender) x 3 (Group) ANOVA revealed an unanticipated significant action x gender interaction effect, $F(1, 66) = 6.30$, $p < .05$. No other effects were significant (See Appendix I, Table I2). The action x gender interaction was explored by examining the effect of action for each sex separately. Paired t-tests indicated an action effect for boys, but not for girls. As predicted, boys looked significantly longer at the incongruent actions, $M = 3.76$, $SD = .66$, than at the congruent actions, $M = 3.29$, $SD = .42$, $t(34) = -3.61$, $p < .01$. In contrast, there was not a significant difference between girls' mean fixation to the incongruent actions ($M = 3.53$, $SD = .49$) and their mean fixation to the congruent actions ($M = 3.58$, $SD = .58$, $t(36) = -.42$, $p > .05$).

Given the finding of this interaction in the analysis of raw scores, against-chance comparisons involving percentage scores were done for each sex separately. Initially, we anticipated that children would show greater than chance fixations to the incongruent actions. Once again, the predicted pattern was obtained for boys, but not for girls. For boys, against-chance comparisons indicated a marginal incongruency effect at 18 months (M= 52.21%, $SD = 3.54$, $t(10) = 2.07$, $p = .032$), and a significant incongruency effect at 30 months (M = 54.06%, $SD = 7.29$, $t(14) = 2.16$, $p < .025$). While 24-month-old boys' mean fixation to the incongruent stimuli did not differ significantly from chance, it was in the same direction as that obtained for the other age groups (M = 51.53%, $SD = 3.68$, $t(8) = 1.25$, $p > .05$). In contrast to the boys, girls' mean percent fixation to the incongruent actions did not exceed chance levels at any of the ages tested. Girls' mean percent fixation to the incongruent actions at 18, 24, and 30 months were 50.85% ($SD = 6.33$), 50.17% ($SD = 4.34$), and 49.16% ($SD = 6.32$), respectively. T-values for these comparisons (.47, .14, and -.48) were all nonsignificant at an alpha level of .05.

An analysis of individual subjects confirmed that boys succeeded better on the control task than did girls. While 23 out of 35 boys showed that predicted mismatch pattern, defined as greater than chance looking at the incongruent actions), only 17 out of 37 girls showed this pattern.

Desire-Emotion Task Results: Analysis of Standard Trials

Of the 92 children who completed the task, two were eliminated because of side biases, and three others because they did not produce enough valid data to allow computation of all scores. Therefore, the final sample included 87 children: twenty-eight 18-month-olds, thirty 24-month-olds, and twenty-nine 30-month-olds. For the final sample, the percentage of trials eliminated in the Desire-Emotion task (standard trials) was 4.46%, 8.33% and 3.45% for the 18-month, 24-month, and 30-month-old samples, respectively.

A 2 (Emotion) x 2 (Outcome) X 3 (Group) mixed factor ANOVA was conducted to test our hypotheses. Of particular interest was whether subjects would be able to link a person's emotional reactions to outcomes relating to that person's desire. Such understanding would be indicated by a significant emotion x outcome interaction. Prior to running the final ANOVA, a preliminary analysis was conducted to rule out interactions of gender and order with our variables of interest. Neither gender nor order was found to interact with these variables.

The 2 (Emotion) x 2 (Outcome) X 3 (Group) ANOVA failed to yeild the predicted interaction effect involving emotion and outcome. However, there was a significant main effect of emotion, $F(1, 84) = 52.09$, $p < .01$, and a significant main effect of group, $F(2, 84) = 4.27$, $p < .05$ (see Appendix I, Table I3). As shown in Figure 4, children looked longer at the sad expressions (M = 3.93, SD = .84) than at the happy expressions (M = 3.14, SD = .48), regardless of outcome condition. A Tukey test was conducted to examine the group main effect. This test revealed no significant difference in looking times across ages, however, children in the oldest group appeared to have somewhat longer mean looking times than children in the younger age groups, possibly reflecting maturational increases in attention.

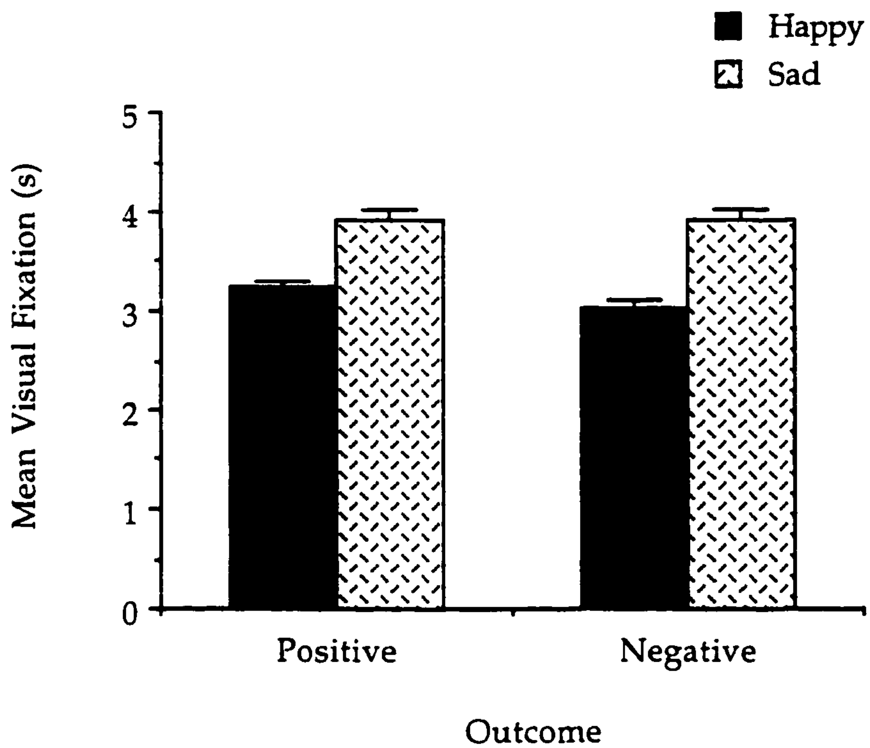


Figure 4. Visual Fixation in Seconds to the Happy and Sad Faces as a function of Outcome Condition

Against-chance comparisons were conducted using mean percent fixations to the incongruent test stimuli (i.e., the sad expression on positive outcome trials, and the happy expression on negative outcome trials). It was predicted that, for each age group, mean fixation to incongruent expressions would be significantly greater than chance. Instead, children's looking behaviors appeared to vary in accordance with the emotion displayed, regardless of outcome. In the positive outcome condition, in which the actor's desire was satisfied, percent fixation to the sad expression (incongruent stimulus) was significantly greater than chance at 18 months (M = 54.27%, SD = 9.89, $t(27) = 2.29$, $p < .025$) and at 30 months (M = 55.67%, SD = 8.86, $t(28)$ = 3.44, $p < .025$), and marginally above chance at 24 months (M = 53.15%, SD = 8.91, $t(29) = 1.94$, $p = .031$). In the negative outcome condition as well, children exhibited greater than chance fixations at the sad expression (congruent stimulus) at 18 months (M = 54.37%, SD = 8.59, $t = 2.69$, $p < .025$), 24- months (M = 56.94%, SD = 10.37, $t = 3.67$, $p < .025$), and 30 months (M = 56.75%, SD = 6.59, $t = 5.52$, $p < .025$). This pattern of results is consistent with a bias toward the sad facial expression. That is, children seemed more interested in the sad face, regardless of whether the protagonist's desire had been fulfilled or not.

Given children's bias for looking at the sad face, we decided to evaluate individual patterns of responding by directly comparing a child's mean fixation to sad facial expression in the positive and negative outcome conditions. This was achieved by subtracting a child's mean percent fixation to the sad face in the negative outcome condition from his or her mean percent fixation to the sad face in the positive outcome condition. Even if a child had a preference for the sad face, he or she was expected to look longer at the sad face in the positive outcome condition than in the negative outcome condition, thereby obtaining a difference score of 1 percent or greater. For each of the age groups tested, individual children were classified according to whether their difference score was greater than or equal to 1.00% (incongruency pattern), -1.00% or less (congruency pattern), or between -1.00 and 1.00 (chance responder). Although we had expected incongruency responders to outnumber other kinds of responders, a congruency pattern predominated. That is, more children showed preferential attention to the sad face in the negative condition ($\underline{n}$ = 48) than in the positive condition ($\underline{n}$ = 33), suggesting that they may have approached the task as a "matching task," looking preferentially at the facial expression that fit with the outcome.

An overall chi square test for k samples was used to compare the distribution of children across two response categories (congruency versus incongruency and chance combined). This test was not significant, suggesting that the distribution of children of different ages across the two response categories did not vary as a function of age, X^2 (2, $\underline{N}$ = 87) = .60, $\underline{p} > .05$. Collapsing across age, a significant difference was not found between the number of children demonstrating a congruency pattern ($\underline{n}$ = 48) versus the other two response categories combined ($\underline{n}$ = 39), x^2(1, $\underline{N}$ = 87) = .931, $\underline{p} > .05$. Thus, the analysis of individual subjects failed to provide support for an understanding of desire-dependent emotion in children aged 18 to 30 months.

Desire-Emotion Task Results: Analysis of Control Trials

Of the 92 children who completed the task, two were eliminated because of side biases, and four others because they did not produce enough valid data to allow computation of all scores. Therefore, the final sample included eighty-six children: twenty-nine 18-month-olds, twenty-nine 24-month-olds, and twenty-eight 30-month-olds. For the final sample, the percentage of trials eliminated in the control analysis was 6.90%, 6.90% and 1.78% for the 18-month, 24-month and 30-month-old samples, respectively.

A mixed factor analysis of variance was conducted to test our hypotheses. As in the analysis of the four standard trials, we were interested in whether children could link a person's emotional reactions to outcomes relating to that person's desires. In order to succeed on these trials, children needed to pay attention to the protagonist's desire, thus a tendency to respond in accordance with personal object preferences would result in null findings.

A preliminary analysis was conducted to rule out the possibility that gender or order interacted with our variables of interest. Neither was found to interact with these variables. A 2 (Emotion) x 2 (Outcome) X 3 (Group) mixed factor ANOVA failed to demonstrate the expected emotion by outcome interaction, suggesting that children did not consider a person's previous desire when presented with her emotional reaction to a desire-relevant outcome (see Appendix I, Table I4). As in the analysis of standard trials, there was a significant main effect of emotion, F (1,83) = 82.85, $p < .01$, reflecting a bias for looking longer at the sad expressions (M = 3.81 sec., SD = .81) than at the happy expressions (M = 2.84 sec., SD = .63), regardless of outcome condition. No other effects were significant.

Against chance comparisons based on percentage scores also failed to support our predictions, which were that children would respond with greater than chance fixations to the incongruent test stimuli, (i.e., the sad face on positive outcome trials, and the happy face on negative outcome trials). Instead, children seemed to prefer the sad expressions, regardless of outcome condition. Thus, mean percent fixation to the incongruent stimuli (sad faces) was above chance in the positive outcome condition as predicted at 18 months (M = 55.73%, SD = 10.86, t(28) = 2.84, $p < .025$), 24 months (M = 55.27%,

$SD = 9.20$, $t(28) = 3.09$, $p < .025$), and at 30 months ($M = 56.58\%$, $SD = 7.86$, $t(27) = 4.43$, $p < .025$). Similarly, in the negative outcome condition, mean percent fixation to the incongruent stimuli (happy faces) was actually below chance at 18 months ($M = 41.40\%$, $SD = 6.68$, $t(28) = -6.94$, $p < .025$), 24 months ($M = 41.23\%$, $SD = 10.69$, $t(28) = -4.42$, $p < .025$), and at 30 months ($M = 42.34\%$, $SD = 9.20$, $t(27) = -4.40$, $p < .025$).

As in the analysis of standard trials, difference scores were computed for individual children by subtracting the child's mean percent fixation to the sad face in the negative outcome condition (congruent stimulus) from their mean percent fixation to the sad face in the positive outcome condition (incongruent stimulus). Children were expected to look longer at the sad face when it occurred in the context of a positive outcome than a negative outcome, resulting in difference scores of 1% or greater. For each of the age groups tested, individual children were classified according to whether their difference score was equal to or greater than 1 (incongruency pattern), -1 or less (congruency pattern), or equal to zero (chance pattern). Although initial predictions were that incongruency responder would outnumber children showing the other two patterns, it was observed that in fact a majority of children looked longer at the sad face in the negative condition ($n = 47/86$) than in the positive condition ($n = 34/86$) , suggesting that children chose the facial expression that matched the outcome. In sum, this pattern is the same as that observed in the analysis of standard trials.

An overall chi square test for k samples comparing congruency versus incongruency and chance responder combined was used to compare the distribution of children across two response categories. This test was not significant, suggesting that the distribution of children across the 2 response categories did not vary as a function of age, X^2 $(2, N = 86)= 0.98$, $p > .05$.

Collapsing across age, a significant difference was not found between the number of children classed as congruency responders (n = 47) versus the other two response categories combined (n = 39), $x^2(1, N = 86) = .74, p > .05$.

Discussion

Desire-Action Task

The purpose of the Desire-Action task was to evaluate whether toddlers understand that people's desires for objects have a direct influence on their subsequent actions involving those objects. If infants possess this understanding, then they should be perplexed and exhibit increased attention when a person behaves in a manner that is inconsistent with his or her desire. The results of the Desire-Action task largely supported our predictions. In the analysis of standard trials, group results based on two kinds of measures (raw scores and percentage scores) were consistent with the hypothesis that infants recognize the causal influence of desires on human action. In particular, children as young as 18 months exhibited significantly longer fixations to the incongruent stimuli, in which the protagonist's actions conflicted with her previously stated desires. Furthermore, an analysis of individual children showed that, at all ages, a significantly larger number of children attended preferentially to the incongruent stimuli as opposed to the congruent stimuli.

The analyses involving the control trials provided partial support for our hypotheses. Recall that the purpose for including these trials was to help rule out a possible object preference interpretation of success on the standard trials. If success on the standard trials was simply the result of children's object preferences, then a main effect of action was not expected on the analysis involving the control trials, since a preference for a particular item in an object pair would lead a child to look at the congruent screen on one trial and at the incongruent screen on the corresponding trial, resulting in null findings.

When group analyses were conducted, only boys demonstrated a clear understanding that desires influence actions, whereas girls failed to demonstrate this knowledge. Boys' success on the control trials is important, since it helps to rule out an object preference account of the strong results obtained in the standard task. The gender effect obtained in the analysis of control trials was unanticipated, and may be a spurious finding. In any case, children appeared to have been fatigued during the control trials, as indicated by the fact that many of the children who met inclusion criteria for the standard task subsequently failed to meet inclusion criteria for the analysis of control trials ($\underline{n}$ = 16, 7 girls and 9 boys). Control trials always occured at the end of the testing protocol, making them less reliable than the standard trials.

In summary, the Desire-Action task (standard and control trials) provided good evidence that children as young as 18 months have some understanding about the relationship between desires and actions. Specifically, when given verbal and nonverbal cues (point and gaze) about a person's desire, children seemed to expect subsequent actions consistent with that desire. However, because children were provided with cues relating to the protagonist's desire <u>and</u> attentional focus, it is not certain whether children were associating actions with desires, or simply with attentional states. So at present, one can only conclude that the present findings are <u>consistent</u> with an interpretation of an understanding of desire-dependent action.

Having said this, drawing too firm distinction between attentional and desire cues may be problematic for the reason that "attentional cues" such as point and gaze may be considered to convey some affective information relating to a person's desire. According to one analysis (Baron-Cohen, 1991), understanding attention requires the understanding that vision may be directed selectively, and that its direction depends on the person finding the object or event of interest. Thus, a person's gaze provides information not only about what the person sees, but also information regarding the emotional impact of the object or event on the observer. Nonetheless, it is still worth asking which verbal and nonverbal cues contribute most to infants' predictions about a person's subsequent actions, and to their inferences about what a person desires (e.g., Lee, Eskritt, Symons & Muir, in press). To test the contribution of various cues using the present task, one could readminister the Desire-Action task with specific cues (e.g., point, or the word "want") removed, in order to see whether the same pattern of findings would be obtained.

Desire-Emotion Task

The purpose of the Desire-Emotion task was to assess toddlers' understanding of the desire-dependent emotions of happiness and sadness. Contrary to our predictions, the results of this task (analysis of standard trials and analysis of control trials) did not provide evidence for this form of social understanding at the ages tested. Surprisingly, even 30-month-olds seemed unaware that happy and sad reactions are related to a person's pre-existing desires. While it is possible that these findings reflect a genuine deficit in infants' social understanding, several factors make such a conclusion unwarranted. Firstly, older 2-year-olds have demonstrated an understanding of desire-dependent emotions on verbal tasks, which tend to be more difficult than nonverbal tasks (Wellman & Woolley, 1990). This suggests that children's failure on our task is to be explained by methodological rather than conceptual factors.

One possible explanation of children's failure on the task is that their own object preferences prevented them from taking into account the protagonist's desire, resulting in a pattern of null findings. The analysis of control trials was intended to help address this possibility. The null results of the analysis involving control trials are consistent with an object preference interpretation. However, a more likely explanation for failure on this task has to do with children's bias for looking at the sad expression. Although children might recognize that desires impact on emotional reactions, their overwhelming interest in the sad expression appears to have interfered with their ability to demonstrate this understanding. During the test phase of trials (standard and control), children were always presented with one image of the actress displaying a happy expression, and a second image of her displaying a sad expression. In order to show the predicted response pattern, children needed to preferentially attend to the sad face on some trials and to the happy face on others, depending on the type of outcome indicated. Instead, children in the present study found the sad expressions so compelling that they showed longer fixations to these expressions, regardless of outcome.

The strong preference for the sad face over the happy face obtained in the Desire-Emotion task was not anticipated, although some research has suggested the existence of an attentional bias for negative social information among adults (Hansen & Hansen, 1988; Pratto & John, 1991). One explanation for the present findings has to do with the relative novelty of sad expressions for infants. Supporting this view, there are reports that infants see relatively few negative expressions for at least the first 6 months of life (Malatesta & Haviland, 1982). Malatesta and Haviland found that, when interacting with their infants, mothers' emotional expressions were dominated by interest and enjoyment, followed by surprise and brow flashes, and that mothers tended to mirror their infants' positive expressions, but not their negative expressions. Anger and sadness were displayed with older infants only, and these were typically "mock expressions."

While a novelty effect seems to account well for infants greater interest in the sad expression, one study involving 9-month-olds found that infants gazed at their mothers <u>less</u> when they posed sad expressions than when they displayed a joyful expression (Termine & Izard, 1998). Similarly, studies employing face-to-face paradigms find that infants typically respond to simulated depression with gaze aversion, suggesting that infants find sad expressions stressful (Tronick, Ricks, & Cohn, 1982). The discrepancy between our results and those just described may be explained in a number of ways. One explanation has to do with the duration of exposure to the emotional expressions. Whereas we observed infants' reactions for a brief period of 8 seconds, children in Termine and Izard's study (1988) were exposed to maternal facial expressions over a much longer interval.

Another possible explanation for the discrepant research findings is that there are developmental changes in how children respond to facial expressions. This hypothesis gains some support from the results of Experiment 1, in which it was found that children's preference for the surprised face over the neutral face decreased between the ages of 18 and 30 months. With regard to sad expressions, it is possible that all infants find these expressions interesting due to their relative novelty, but that younger infants also find them somewhat aversive. In line with this interpretation, Termine and Izard (1988) found that infants displayed more interested facial expressions in the sad condition than in the joyful condition, despite the fact that overall looking to the mother was diminished in the sad condition. This suggests that infants find sad expressions to be interesting from an early age, but that younger infants are also disturbed by such expressions, resulting in greater gaze aversion.

Another possible account for the discrepant findings may have to do with the fact that children in our study were presented with videotaped images of a stranger's face, whereas subjects in the other studies cited were typically exposed to live expressions posed by their caregivers. For example, it is possible that negative facial expressions posed by a stranger, or presented in video, are less disturbing to infants than the live expressions of a caregiver. While this explanation has some common-sense appeal, it seems less likely given the finding that the still face effect can be generated by strangers (Ellsworth, Muir, & Hains, 1993).

A further hypothesis is that the greater attention paid to the sad expressions by infants was mediated by cognitive processes with adaptive significance. As mentioned earlier, some research suggests that adults automatically assign more importance or weight to negative social information than to positive social information. For example, using a Stroop color-naming task, Pratto and John (1991) found that subjects' response latencies were longer when presented with negative social labels (e.g., sadistic) than when presented with positive labels (e.g., honest, outgoing). Similarly, incidental recall was greater for negative labels than positive labels. Based on these findings, it was concluded that attentional ressources are automatically allocated to negative social information and that this may serve a protective function for the individual.

Also relevant to the present findings, Hansen and Hansen (1988) found a similar bias for negative information on a task involving negative facial expressions. In their study, college students were asked to survey crowds of faces in order to identify a discrepant emotional expression. The results revealed an interesting asymmetry in which subjects were more efficient at identifying an angry face embedded in a crowd of happy faces than at finding a happy face embedded in an angry crowd. Thus, support was obtained for the authors' hypothesis that that faces can be rapidly processed for features of facial threat. The present findings with young children are important as they suggest that an attentional bias for negative social information may be present from the age of 18 months or earlier, and that sad faces may have the same eye-grabbing effect as do angry faces. That is, sad faces may pop out of a happy or neutral crowd in much the same manner that angry faces do.

Experiment 3: Desire Follow-up Experiment

In order to resolve some of the interpretive questions raised by Experiment 2, a similarly designed follow-up experiment was conducted which consisted of a Desire-Action Follow-up task and a Desire-Emotion Follow-up task. The revised experiment was administered to 24-month-old children. One difficulty with Experiment 2 is that children's success on the Desire-Action task may have been based on spatial cues associated with the visual displays, as opposed to a true understanding of how desires guide actions. An additional problem concerned the simultaneous presentation of the happy and sad expressions during the test phase in the Desire-Emotion task, since children's bias for the sad face made it difficult to test our hypotheses. For this reason, some modifications to the original tasks were made in an effort to render them more valid tests of infants' understanding of desire-dependent action and desire-dependent emotion.

Desire-Action Follow-up Task

Although the results of Experiment 2 supported the hypothesis of an understanding of desire-dependent action in children as young as 18 months, other interpretations of infants' performance on this task are possible. One possibility is that infants succeeded on the basis of spatial cues. Indeed, because the relative position of the two objects on the table remained constant throughout trials, the incongruent test stimuli always depicted a change in the protagonist's body orientation relative to the information phase, whereas the congruent stimuli depicted no such change. This is because in the incongruent test stimuli the protagonist was shown reaching for the nondesired object, while previously she had pointed to the desired object. Thus, infants may have preferentially attended to the incongruent stimuli simply because they depicted a relatively novel change of orientation (e.g., pointing to the right object, reaching for the left object).

In order to address this possible confound, we modified the Desire-Action task by systematically reversing the location of the two objects on the table between the information phase and the test phase. The effect of this manipulation was to render the incongruent test images less novel than the congruent images, as the direction of the pointing gesture was the same in the information phase and the test phase. If infants were simply responding to spatial cues, then they were expected to show a congruency pattern in the modified task (i.e., longer fixations to the congruent actions), since the congruent test stimuli now depicted a change in orientation. In contrast, to succeed on the follow-up task, infants needed to ignore spatial cues and keep track of the desired object instead.

Another possible interpretation of success on the original Desire-Action task is that children solved the task on the basis of the relative amount of attention allocated to the desired and nondesired objects during the information phase. While the protagonist attended to both objects in the original task, she spent more time looking at and gesturing towards the desired object. As such, it is possible that infants looked longer at the incongruent screen because it showed the actress reaching for a relatively novel object, to which she had paid less attention during the preceding information phase. Again, the argument is that infants may have solved the task on the basis of superficial cues, rather than through a true conceptual understanding.

To address this issue, we attempted to control for the amount of attention devoted to each member of an object pair by having the actress gesture towards and comment on both objects to an equal extent during the information phase. While infants still received verbal and gestural cues (e.g., point) about which item the actress desired, they could no longer solve the task on the basis of the amount of attention given to each object in the information phase. In all other respects, the Desire-Action Follow-up task was identical to the original Desire-Action task.

Desire-Emotion Follow-up Task

The purpose of the Desire-Emotion Follow-up task was to further explore whether children appreciate the role of desires in happy and sad emotional reactions. The main revision to the original Desire-Emotion task was intended to address the salience effect of the sad face. In the original task, children learned about an actor's desire and witnessed one outcome relevant to that desire (receiving or not receiving the desired object) in the information phase, and then viewed the actor responding with happy and sad facial reactions during the test phase. In the follow-up task, trials were redesigned so that happy and sad faces were never presented simultaneously during the test phase. Children were given information about the actress' desire in the information phase, but this time the outcome was kept ambiguous. During the test phase, two different outcomes were depicted and emotion was held constant. So on the happy trials, children saw the actress holding the desired object and smiling on one screen, and holding the nondesired object and smiling on the other screen. Sad trials were identical except that the actress displayed a sad face in response to each of the different outcomes. The advantage of the revised design was that children's interest in the sad face could not hamper their performance on the task. Instead, they were only required to notice how the emotional expression presented related to each of the different outcomes.

Because of the modifications just described, the Desire-Emotion Follow-up task differed from the original task in several respects. In the original task, subjects saw the protagonist being given an object during the information phase, and this object appeared on both screens during the test phase. In the modified task, children had to infer that the protagonist had been given an object, and the protagonist was shown holding a different object on each screen during the test phase: the desired object on one screen (positive outcome) and the nondesired object on the other screen (negative outcome).

Thus, one important repercussion of holding emotion constant for each trial was that it became necessary to present a different object on each of the two test screens. Unfortunately, this modification raised the possibility that a child's attention to the two test screens on a given trial might be influenced by his or her preference for looking at specific objects. For example, if a child fixated longer at the image of the actress responding with a sad expression while holding a cup that she had just requested, this could mean that the child understands desire-dependent emotion. Alternatively, it may simply reflect a preference for looking at cups as opposed to bowls, the object appearing on the other screen.

In order to address this difficulty, we designed two control trials which were identical in all respects to two of the standard trials, with the exception that the desired and nondesired items in the control trials were the reverse to what they had been in the standard trials. For example, when presented with a cup-bowl pair, the protagonist's desire was for the cup in the standard trial and for the bowl in the corresponding control trial. By including these trials it was possible to assess for the predicted emotion x outcome interaction, without the potentially confounding influence of object preferences. If a child had a strong object preference, he or she was expected to look at the screen depicting his or her preferred member of the object pair (regardless of the desire, emotion, and outcome information provided), leading the child to attend to the incongruent stimulus on one trial and the congruent stimulus on the corresponding trial.

A general prediction for the Desire-Emotion Follow-up task (standard and control trials) was that children's looking time to the two outcomes (desired object and nondesired object) would vary with the emotional expression being displayed. In line with an incongruency pattern, we expected that children would look longer at the positive outcome screen on sad face trials and at the negative outcome screen on happy expression trials. Assuming that children did not have strong object preferences, we expected the same pattern of results in the analysis of control trials as in the analysis of standard trials.

Method

Participants

Participants in this study were recruited from birth lists obtained from the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre after approval by the Commission d'Accès à l'Information du Québec. The initial sample included thirty-one 24-month-olds (M = 24.55 months, range = 23.78 to 26.00 months), 16 boys and 15 girls. Children were from English-speaking homes and had no impairments in hearing or vision, as reported by their parents. Children's socioeconomic status was estimated using occupational ratings of the Blishen, Carroll and Moore (1981) index (M = 42.74, SD = 13.28). Children were assigned a single socioeconomic status (SES) score that corresponded to the highest occupational score obtained by either parent. The mean SES score for participants in the experiment was 54.34 (SD = 12.69) and ranged from 25.56 to 71.70 indicating that subjects were of average socioeconomic status.

Apparatus

Infants were tested using the same adaptation of the preferential looking paradigm and procedure as that used in Experiments 1 and 2.

Stimuli

Two series of videotaped trials were developed. As before, each trial included an information phase and a test phase. The revised Desire-Action task and the revised Desire-Emotion task consisted of six trials each (4 standard and 2 control). During the information phase, a videotaped story segment was presented on one of the television monitors, while the other monitor was blank, displaying only a solid blue background. Information phases were followed by test phases that commenced with the onset of 2 still images, one on each monitor. As in the previous experiments, the 2 still images presented in the test phase were intended to constitute two different "endings" (congruent and incongruent) to the story depicted in the information phase. The duration of the information phase varied slightly from trial to trial, ranging from 26 to 28 seconds in the Desire-Action Follow-up task and from 20 to 24 seconds in the Desire-Emotion Follow-up task. Test phases lasted 8 seconds, and an interval of 0.66 seconds occurred between the two phases to encourage looking at both screens during the test phase. A 3-second interval during which both screens were blank was interspersed between trials.

In the Desire-Action Follow-up task, the infant viewed a videotape of an actress seated at a table with two objects before her (e.g., apple and banana). For the four standard trials, the pair of objects located on the table was different for each trial, so as to maintain infants' interest, and to eliminate possible ambiguity about which object the actor desired on a given trial. On the two control trials, object pairs matched those used in two corresponding standard trials. However, in the control trials the identity of the desired and nondesired object were the reverse to what they had been in the standard task. The rationale for including the control trials in the Desire-Action Follow-up task was to ensure that longer looking at incongruent actions was due to an understanding of desire-dependent emotion, and not simply the result of object preferences.

Information phases always began with the actress addressing the subject and labelling the objects on the table (e.g., "Hi baby! Let's see what's on the table. I see an apple and I see a banana."). The actress then conveyed her desire for a specific object, by pointing to it and saying, "I want that one! I want that one!" Having expressed her desire, she directed the infant's attention to the nondesired object by extending her arm towards it with an open palm and saying "Look at that one. Look at that one!" In this manner, equal attention was given to both objects by the actress. On half the trials, the actress indicated what she desired first (refered to as the want-look condition), and in the remaining trials she expressed her desire after asking the infant to attend to the non-desired object (refered to as the look-want condition). The information phase ended with the actress returning her hands to her lap. Following a 0.66-second pause, the test phase began. In the test phase, infants viewed a still frame image of the actress grasping the desired object on one screen, referred to as the congruent action, and a second image of the actress grasping the nondesired object on the other screen, referred to as the incongruent action. The position of the desired and nondesired objects on the table was switched between the information and test phases to ensure that children were not simply responding on the basis of spatial cues.

A second series of trials was developed for the Desire-Emotion follow-up task (four standard and two control trials). Again, trials included an information phase and a test phase. During the information phase, subjects viewed two actresses sitting at a table. On the table before one of the actresses was a pair of objects (See Appendix J for a schematic representation of the stimuli used in Experiment 3). For the four standard trials, the pair of objects located on the table varied from trial to trial, so as to maintain infants' interest, and to eliminate possible ambiguity about which object the actor desired on a given trial. On the two control trials, object pairs matched those used in two corresponding standard trials. However, in the control trials the identity of the desired and nondesired object were the reverse to what they had been in the standard task.

Information phases in the Desire-Emotion task began with Actor 2 holding up each of two objects in turn and labelling them for the protagonist (e.g., "See what I have? I have a cup, and I have a bowl."). The protagonist then expressed a desire for a specific object by pointing to it and saying "I want that one. I want that one!" to which Actor 2 responded "I'll give it to you." This phase was immediately followed by a 0.66-second pause and, subsequently, an 8 second test phase. During the test phase of each trial, children saw a still frame image of the protagonist holding the desired object on one screen, referred to as the positive outcome, and a second image of her holding the nondesired object on the other screen, refered to as the negative outcome. On half the trials (standard and control) the actress displayed a happy facial expression on both screens, referred to as the happy condition, and in the remaining trials, she displayed a sad facial expression on both screens, referred to as the sad condition. Thus, in both the happy and sad trials, the emotional reaction of the actress accorded with the outcome presented on one screen, referred to as the congruent stimulus, but conflicted with the outcome presented on the other screen, referred to as the incongruent stimulus. For example, on happy trials, the screen depicting the positive outcome was considered the congruent stimulus, and the screen depicting the negative outcome was considered the incongruent stimulus, since we expect people to display positive affect when their desires are satisfied, not when they are thwarted.

In order to ensure that the emotional expressions used presented to infants were good exemplars of the emotion in question, independent ratings were gathered from 15 adult subjects (6 males and 9 female, M = 23.6) who were tested in small groups. In order to obtain these ratings, six emotional expressions (2 from each experiment) were displayed one at a time on a single television monitor. Expressions were presented in the following fixed order: happy, sad, neutral, surprised, happy, sad. Upon the presentation of each expression, raters were asked to select one of 7 emotion labels (happy, sad, surprised, disgusted, fearful, angry, or neutral) to match the expression displayed. When presented with the happy and sad expressions used in the Desire-Emotion Follow-up task of Experiment 3, all 15 of the adult raters successfully identified the happy expression, and 14 out of 15 selected the correct label for the sad face. Thus the facial expressions presented in the Desire-Emotion Follow-up task appear to have been excellent examples of happy and sad expressions.

Design

The entire experiment consisted of 12 trials, including the four desire-action standard trials, the four desire-emotion standard trials, and the four control trials (two per task). The design of Experiment 3 is shown in Table 3. Trials were administered in a fixed order, such that the standard trials of both the Desire-Action and the Desire-Emotion task were presented before any of the control trials. Because control trials employed the same object pairs as were used in some standard trials, all standard trials were administered first, in an effort to maintain children's interest by presenting as many different object pairs as possible. Furthermore, we wanted to provide infants with unambiguous cues about a person's desire. Had the control trials been interspersed with the standard trials, infants may have become confused when an actor's desire changed abruptly from one object in a pair to the other. The order of presentation was the same for all subjects.

Appropriate counterbalancing was done for both tasks. For both tasks, (Desire-Action Follow-up and Desire-Emotion Follow-up), the side of presentation of the information phase was manipulated, such that the information phase occurred on the left monitor for half the trials and on the right monitor for the remaining trials. In addition, the relative position of the information phase and the incongruent test image on the two television monitors was controlled so that the incongruent test image occured on the same screen as the information phase on only half the trials. This was done to rule out an interpretation of task success in terms of a bias for test images presented on the same side as the information phase.

Other counterbalancing procedures were task-specific. In the Desire-Action task, the order of gestures and comments to the desired and non-desired objects was counterbalanced across trials. On half the trials, the actress

Table 3

Design of Experiment 3

Desire-Action Follow-up Task - Standard trials

Trial	Object pair	Order	Test screen 1	Test screen 2
1	**flower**/clock	WL	reach flower	reach clock (i)
2	banana/**apple**	LW	reach banana (i)	reach apple
3	shoe/**hat**	WL	reach shoe (i)	reach hat
4	**bottle**/glasses	LW	reach bottle	reach glasses (i)

Desire-Emotion Follow-up Task - Standard trials

Trial	Object pair	Emotion	Test screen 1	Test screen 2
5	spoon/**fork**	happy	happy - spoon (i)	happy - fork
6	**green**/red	sad	sad - red	sad - green (i)
7	soap/**brush**	happy	happy - soap (i)	happy - brush
8	**cup**/bowl	sad	sad - bowl	sad - cup (i)

Desire-Action and Desire-Emotion Follow-up Task - Control Trials

Trial	Object pair	Order	Test screen 1	Test screen 2
9	**banana**/apple	LW	reach banana	reach apple (i)
10	flower/**clock**	WL	reach flower (i)	reach clock
11	**spoon**/fork	happy	happy - spoon	happy - fork (i)
12	cup/**bowl**	sad	sad - bowl (i)	sad - cup

Note. Underlined objects represent the objects desired by the protagonist, actor 1.

pointed to and expressed her wish for the desired object first and gestured towards the nondesired object second, while in the remaining trials she did the reverse, gesturing to the nondesired object first and pointing to the desired object second. This manipulation was intended as a memory control. Given the limited memory capacities of infants, it was thought that infants might have more difficulty relating a person's actions to a previously stated desire, when a gesture towards another object followed the statement of desire (i.e., in the want-look condition).

For the test phase, the screen (left versus right) on which the congruent versus incongruent action was presented was counterbalanced across trials. This was done to rule out side preference interpretations of task performance. Furthermore, the relative position of the objects on the table was switched on each trial, so that the object that had been on the actress' right in the information phase was on her left during the test phase. This modification was added to rule out a perceptual salience account of task success. As mentioned earlier, one possible interpretation of children's success on the original Desire-Action task was that they were able to solve the task by detecting a perceptual mismatch between the direction of the actress' point in the information phase and the direction of her reach in the test phase. Due to the position reversal of objects in the follow-up task, this simple strategy was unavailable to infants because the direction of the actress' reach in the incongruent stimuli presented during the test phase in the revised task was the same as the direction of her point in the information phase. If children were inclined to look longer at the image in which the direction of the reach was discrepant with the direction of the point in the information phase, then they would be expected to look longer at the congruent test stimuli.

Similar counterbalancing was done for the Desire-Emotion Follow up task. In this task, the relative locations of the desired and nondesired objects were counterbalanced across trials, such that the desired object was the one closest to the protagonist on half the trials and the one furthest from her on the remaining trials. Furthermore, on half the trials the actress displayed a happy face on both screens, and in the remaining trials, she displayed a sad face on both screens.

Results

Interobserver Agreement

Two observers who were blind to the position of the congruent and incongruent screens recorded the mean looking times at each screen across all trials for a randomly selected 20% of the subjects. Interobserver reliability was assessed using Pearson's product-moment correlation between the two observers' ratings for the Desire-Action and Desire-Emotion tasks separately. Two correlation coefficients were obtained for each task (i.e., time on the right screen and time on the left screen) and were then averaged. Mean interobserver reliability was $r = .973$ for the revised Desire-Action task and $r = .938$ for the revised Desire-Emotion task.

Data Screening

Data screening procedures were the same in this experiment as in experiments 1 and 2.

Data Analysis

The standard and control trials for each task were analyzed separately. For both Desire-Action and Desire-Emotion follow up tasks, the two control trials were analyzed together with the two standard trials having matching object pairs. Group analyses included a mixed factor analysis of visual fixation times (in seconds). In the Desire-Action task (standard and control analyses) there were four scores reflecting children's mean fixation in seconds to the congruent and incongruent actions for each of the two order conditions (look-want and want-look). If no trials were eliminated, then each of these means was based on two observations. In the Desire-Emotion task (standard and control analyses), there were 4 scores representing children's mean total looking time (in seconds) to the positive and negative outcome screens in the happy and sad conditions. If no trials were eliminated, then each of these means was also based on 2 observations.

In order to assess group patterns another way, against-chance analyses using t-tests were conducted, comparing percent looking at incongruent stimuli to chance looking, defined as 50 percent looking time on each screen. Percentage scores were obtained by dividing mean fixation to the incongruent stimuli by total fixation to the congruent and incongruent stimuli combined. In the Desire-Action follow-up task, there was one dependent variable, reflecting percent fixation to incongruent actions, i.e., grasping the nondesired object. In the Desire-Emotion follow-up task, there were two dependent variables: mean percent fixation to the positive outcomes in the sad condition, and mean percent fixation to the negative outcomes in the happy condition. These percentage scores represented the proportion of time spent on the incongruent stimulus out of total fixation to both test stimuli combined.

Finally, individual analyses were done to assess whether the group results were representative of the group as a whole. Children were classified into one of three response categories, according to whether their mean percent fixation to incongruent stimuli (defined in the previous paragraph) was greater than chance (incongruency responder), below chance (congruency responder), or equal to chance (chance responder). Percentage scores were the same as those used in the against-chance comparisons conducted on the whole sample. Having classified children in this manner, we compared the number of children showing an incongruency (or in some cases congruency) pattern to the number of children showing either of the other patterns using a chi-square goodness of fit test. Predictions for the Desire-Action task were that incongruency responders would outnumber other responders. In the Desire-Emotion task, we expected congruency responders to predominate.

Desire-Action Follow-up Task Results: Analysis of Standard Trials

None of the participants in Experiment 3 demonstrated a side bias. Three children were eliminated because they failed to produce sufficient valid data to allow computation of all scores, leaving a final sample of 28 children (14 male and 14 female). Based on the trial elimination criteria described above, 2.7 percent of trials were eliminated for the Desire-Action follow-up task (4 standard trials).

A 2 (Action) x 2 (Gesture-Order) x 2 (Gender) mixed factor ANOVA using mean looking times was conducted (See Appendix K, Table K1). If infants understand that desires guide human actions, a main effect of action was predicted. Specifically, we expected that mean visual fixation to actions that were incongruent with the actor's desire would exceed fixation to actions that were consistent with that desire. No main effect of gesture-order, gender, or any interactions were expected. As shown in Figure 5, the results demonstrated no main effect of action, $\underline{F}(1, 26) = 1.08$, $\underline{p} > .05$. In fact, the ANOVA revealed no significant effects involving any of the variables.

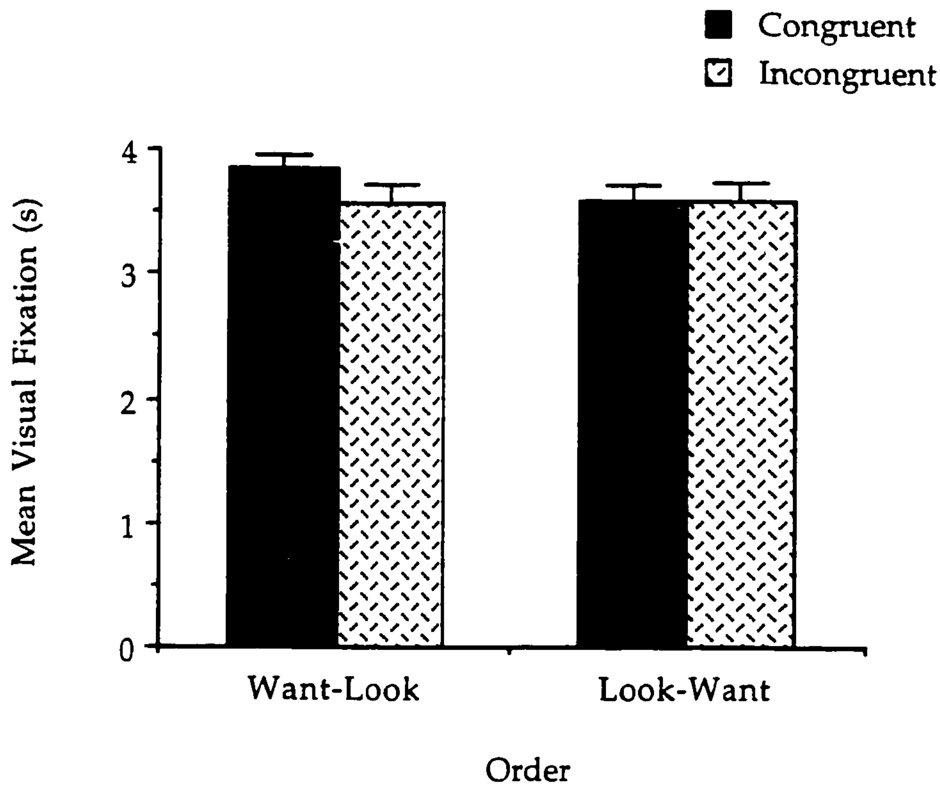


Figure 5. Mean Visual Fixation to the Congruent and Incongruent Actions as a Function of Gesture Order.

Because no effect of gesture-order or gender was obtained, we collapsed across these variables before comparing percent fixation to the incongruent stimuli to chance. While we had predicted that mean fixation to the incongruent stimuli would be significantly greater than chance, the results indicated no such difference. Mean percent fixation to the incongruent actions was not significantly greater than chance, $\underline{M} = 49.13\%$, $\underline{SD} = 4.84$, $\underline{t}(27) = -.96$, $\underline{p} > .05$.

An analysis of individual subjects' response patterns was also undertaken using each child's mean percent fixation to the incongruent actions as a grouping variable. Individual children were classified according to whether their mean fixation to incongruent actions was greater than chance (incongruency pattern), less than chance (congruency pattern), or equal to chance (chance pattern). Our prediction that a larger number of children would show an incongruency pattern than either of the other patterns combined was not confirmed. Results yielded 8 children in the incongruency category, 11 in the congruency category, and 9 in the chance responder category. A chi square goodness of fit test comparing the number of incongruency and number of congruency and chance responders combined to the null hypothesis indicated that the number of children showing an incongruency pattern was not greater than chance. In fact, there were significantly fewer children in the incongruency category than in the other two response categories combined, $\underline{X}^2$ (1, $\underline{N} = 28$) = 5.14, $\underline{p} < .05$.

Desire-Action Follow-up Task Results: Analysis of Control Trials

For the analysis involving the control trials, four children were eliminated because they lacked enough valid data to allow for computation of all dependent variables, resulting in a sample of 27 children (15 male and 12 female). Based on the trial elimination criteria described above, the percentage of trials eliminated was 6.5% for the analysis involving the control trials (2 standard trials and 2 corresponding control trials).

Statistical analyses were conducted using the two control trials and the two corresponding standard trials employing matching object pairs. A 2 (Action) x 2 (Order) x 2 (Sex) mixed factor ANOVA was conducted. It was predicted that if 24-month-old children understood how desires guide actions and they did not have strong object preferences, they would look longer at the incongruent actions on all four trials. Object preferences would interfere with task performance because the task was designed in such a way that if a child consistently attended to the action directed towards a specific member of an object pair, they would be inclined to look at the congruent test image on half the trials and at the incongruent test image on half the trials, resulting in null results.

A 2 (Action) x 2 (Order) x 2 (Sex) mixed factor ANOVA revealed no significant effects involving action, $F(1, 25) = .19$, $p > .05$, or any other variables (Appendix K, Table K2). Against-chance comparisons indicated that the mean percent fixation to incongruent actions ($M = 48.79\%$, $SD = 6.69\%$, $t(26) = -.94$, $p > .05$) was not significantly above chance as we had expected. Also contrary to our predictions, the analysis of individual response patterns did not demonstrate a difference between the number of children showing an incongruency pattern ($n = 9$), as compared to the number of children showing a congruency ($n = 13$) or chance responder pattern ($n = 5$), X^2 $(1, N = 27) = 3.00$, $p > .05$).

Desire-Emotion Follow-up Task Results: Analysis of Standard Trials

For the analysis of standard trials, one child was eliminated because of failure to produce sufficient valid data, resulting in a sample of 30 children (15 male and 15 female). Based on our trial elimination criteria, 0.8 percent of trials were eliminated based on the trial elimination criteria described above.

A 2 (Gender) x 2 (Emotion) x 2 (Outcome) mixed factor ANOVA was conducted. Of particular interest was whether children would associate happy expressions with desire fulfillment (positive outcome), and sad expressions with failure to obtain a desired object (negative outcome). A significant emotion x outcome interaction was predicted, whereas no main effects or interactions involving gender were anticipated.

The results of the ANOVA (see Appendix K, Table K3) were in line with our predictions. Specifically, there was a significant emotion x outcome interaction, $F = 15.61$, $p < .01$ (see Figure 6). Thus, 24-month-olds' attention to the positive and negative outcomes was influenced by the kind of emotion displayed by the actress. There were no main effects of emotion, outcome, or gender. A post hoc analysis consisting of paired t-tests with Bonferonni correction was conducted to examine the effect of outcome within each level of emotion (happy and sad). Results of this analysis indicated that children approached the task as a "matching" task, in which preferential attention was given to the outcome that was consistent with the emotion displayed. On trials in which the actress displayed a happy expression, children looked marginally longer at the test stimulus depicting the positive outcome (M = 4.05, SD = .76) than at the test stimulus depicting the negative outcome (M = 3.55, SD = .70), $t(29) = 2.02$, $p = .027$. When the actor looked sad, children looked significantly longer at the test stimulus depicting the negative outcome (M = 4.36, SD = .78) than at the test stimulus depicting the positive

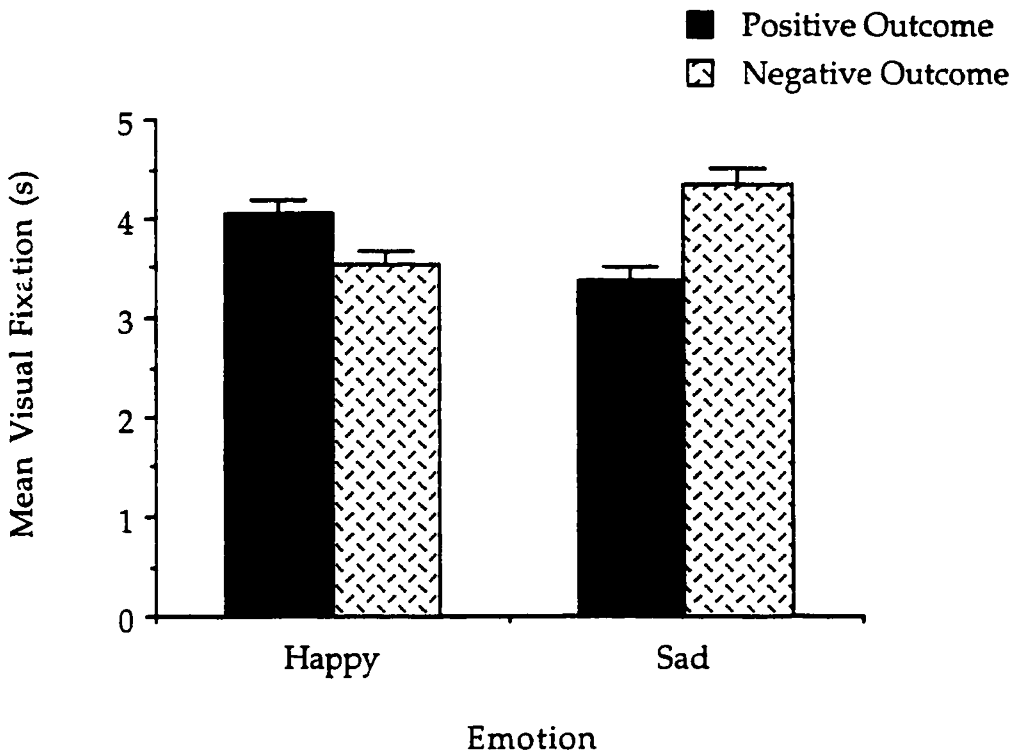


Figure 6. Mean Visual Fixation to Positive and Negative Outcomes as a Function of Emotion

outcome (M = 3.39, SD = .74), $t(29) = -3.58$, $p < .01$. These findings imply an understanding of how emotional reactions relate to desire fulfillment.

Against-chance analyses were also conducted comparing percent looking times to the incongruent stimuli (positive outcome-sad face and negative outcome-happy face) to chance looking. While initial predictions were that mean fixation to the incongruent test stimuli would be significantly greater than chance, paired t-tests suggested that infants actually looked longer at the congruent stimuli, a pattern consistent with the results of the analysis of variance. In the sad condition, children's mean percent fixation to the negative outcome stimulus was significantly above chance, M = 56.23%, SD = 9.32, $t(29) = -3.66$, $p < .01$. In the happy condition, children's mean percent fixation to the positive outcome stimulus was marginally above chance M= 53.20%, SD = 8.74, $t(29) = -2.01$, $p = .027$.

Finally, individual infants were classified as to whether they showed an incongruency, congruency, or chance pattern of responding. Two goodness of fit tests were used to determine whether the number of children preferentially attending to the congruent stimuli was significantly greater than the number of children exhibiting one of the other two response patterns combined. Results showed that in the sad condition, significantly more children showed a congruency pattern (n = 25) than either of the other patterns combined (n = 5), $X^2(1, N = 30) = 13.33$, $p < .01$. This pattern was not obtained in the happy condition, where children showing a congruency pattern (n = 17) did not significantly outnumber children showing either an incongruency or chance pattern (n = 13) of responding, $X^2(1, N = 30) = .53$, $p > .05$.

Desire-Emotion Follow-up Task: Analysis of Control Trials

One child was eliminated based on the criteria described earlier, leaving a sample of thirty 24-month-old children (15 male and 15 female). Based on the trial elimination criteria outlined above, the percentage of trials eliminated in the control task was 4.2%.

It was predicted that the desire-emotion control analysis would yield results similar to the standard task. That is, we expected an interaction of emotion and outcome in the congruent direction, meaning that children would show preferential attention to outcomes that matched the kind of affect being displayed by the actress. The analysis with control trials was designed in such a way that children with strong object preferences would not show the predicted pattern of responding, but would attend equally to the congruent and incongruent stimuli instead.

A 2 (Emotion) x 2 (Outcome) x 2 (Sex) mixed factor ANOVA revealed no significant effects (Appendix K, Table K4). In other words, we did not replicate the emotion x outcome interaction obtained in the analysis of standard trials. Children's fixations to the screens depicting the positive and negative outcomes did not vary as a function of the type of affect displayed by the actress. T-tests comparing percent looking times to the incongruent stimuli (positive outcome-sad expression and negative outcome-happy expression) to chance also yielded nonsignificant results. Mean fixation to the incongruent stimulus was not different from chance in the happy (M = 50.40%, SD = 6.72, $t(29) = .33$, $p > .025$) or in the sad condition (M = 48.35%, SD = 10.26, $t(29)$ - .88, $p > .025$).

The analysis of individual subject's response patterns also failed to support our predictions. Two goodness of fit tests (for happy and sad conditions) were conducted to determine whether the number of children showing a congruency pattern was significantly greater than the number of children exhibiting one of the other two response patterns combined. Results indicated that in the sad condition, congruency responders ($n = 16$) were not more numerous than incongruency ($n = 11$) and chance responders ($n = 3$) combined, $X^2(1, N = 30) = 1.2$, $p > .05$. Similarly, in the happy condition, congruency responders ($n = 10$) were not more numerous than incongruency ($n = 14$) and chance responders ($n = 6$) combined, $X^2(1, N = 30) = 3.33$, $p > .05$.

One account for the null findings on these trials is that individual subjects had preferences for specific objects, which lead them to attend to the congruent screens on half the trials and to the incongruent screen on the remaining trials. In order to explore this possibility further, we assessed the number of children showing object preferences by computing percent visual fixation to the screen displaying an object in the trial where it was desired by the protagonist, and in the trial where it was not. A child was considered to have an object preference if her visual fixation to the screen displaying a particular object was 51.00% or greater across both trials. Based on this lenient criterion for identifying preferences, only half the subjects showed evidence of object preferences ($n = 17$ for the fork-spoon pair, and $n = 14$ for the bowl-cup pair). Thus, object preferences cannot fully account for the null findings.

An alternative account is that infants were unable to solve the control task due to the fact that the protagonist's desire for a specific item of an object pair changed from the standard trial to the corresponding control trial. If children this age do not appreciate the potentially changing nature of desires, they may have become confused in the face of the apparently conflicting information about the protagonist's desire, leading to difficulty in the control trials but not in the standard trials. Finally, given that control trials were presented at the end of the experiment, it is possible that infants' poorer performance on these trials is related to fatigue. To evaluate this possibility, we compared children's on-screen fixation times during the control trials (n = 2) to fixation times during the standard trials to see whether children's attention to the task appeared to diminish during the control trials. In support of a fatigue explanation, infants' mean on-screen fixation was significantly lower during the control trials (M = 3.56 seconds, SD = .39 seconds) than during the standard trials (M = 3.82 seconds, SD = .21 seconds), $t(29) = 3.31$, $p < .01$.

Discussion

Desire-Action Follow-up Task

The purpose of the Desire-Action Follow-up task was to provide additional evidence for early understanding of desire-dependent action while ruling out certain interpretative difficulties associated with the original task. Contrary to our predictions, 24-month-old children failed the modified task. Instead of looking longer at the incongruent actions, infants in Experiment 3 tended to look equally long at the congruent and incongruent actions in the standard trials. In the analysis of control trials as well, children failed to show the predicted action effect, suggesting that they did not perceive the desire-inconsistent actions as puzzling. The control trials were administered in order to help rule out an object preference interpretation in the case of a significant main effect of action in for the analysis of standard trials. Given that the predicted action effect was not obtained for the standard trials, it is not surprising that children failed the control task which was arguably more difficult since children needed to keep track of the protagonist's current desire, which was the opposite in the control trials to what it had been in the standard trials.

There are several possible explanations for failure on the modified Desire-Action task. One possibility is that 24-month-olds do not understand how desires influence actions, and their apparent understanding in Experiment 2 was actually due to their reliance on certain perceptual cues only. This seems unlikely given that knowledge of how desires guide actions has been demonstrated in older 2-year-olds using a verbal paradigm (Wellman & Woolley, 1990). A more likely explanation is that task demands, rather than conceptual limitations, account for task failure. In particular, modifications to the original task intended to control for potential confounds may have had the unintended effect of making the revised task far more difficult than the original task.

One potentially challenging aspect of the Desire-Action Follow-up task, which did not characterize the original task, was the switch of object location occurring between the information phase and test phase. This manipulation may well have confused infants about the identity of the desired object. For example, children who encoded both the location and the identity of the desired object in the information phase, may have become confused in the test phase when the nondesired object suddenly appeared in the location where the desired object had just been. Although previous research suggests that young infants can keep track of a goal object when it is moved to a new location (Woodward, 1996), this ability was demonstrated in a context where infants witnessed the change in location of the goal object. In our study, infants did not witness the change of location, but had to infer it instead. Given the limited duration of the test phase, it is possible that switching the location of objects on the table increased task demands to the point where infants were unable to demonstrate their knowledge of desire-dependent actions. Certainly in real life, objects do not typically change position magically from one moment to the next.

Another feature of the follow-up task that may explain the null results is the fact that the protagonist paid equal attention to the desired and nondesired objects in the information phase. In the real world, people typically attend more to objects they desire, making allocation of attention an important behavioral cue about what a person desires. By equating the amount of attention the actress paid to each object, we may inadvertently have created the impression that the actress desired or liked both objects. While it is true that she verbally expressed a desire for only one object, there were gestural and verbal indicators to suggest that she found the other object interesting as well. Given this aspect of the design, it is quite plausible that subjects construed the actress as being interested in both objects. Therefore, infants may have considered an action directed towards either object to be congruent. For future studies, it can be argued that more attention should be given to a desired object, since this is one of the ways in which people express a desire for an object. Alternatively, one may want to convey information about desire by having a protagonist display different emotional reactions in response to different objects (e.g., Repacholi & Gopnik, 1997).

While the modified task did not yield the confirmatory evidence that we had hoped to find, it did help to rule out the spatial-cue interpretation of success in Experiment 2. It was suggested that infants may have attended more to incongruent actions in the original task because of a perceptual mismatch between the direction of those actions and the direction of the point in the information phase. If infants were indeed responding to spatial cues in this manner, then they should have demonstrated a main effect of action in the congruent direction in the follow-up task. This pattern was not obtained, suggesting that infants' success on the original task was not simply the byproduct of salient spatial cues, but reflected conceptual understanding instead.

Desire-Emotion Follow-up Task

The purpose of the Revised Desire-Emotion task was to assess toddlers' understanding of the link between desires and the emotions of happiness and sadness. The results indicated that 24-month-old children do understand how desires relate to the emotions of happiness and sadness. The analysis of standard trials provided particularly compelling support for this understanding, as infants looked longer at outcomes that matched the emotional expression being displayed than at outcomes that did not. Initially, we had expected the opposite pattern of results. That is, we had anticipated longer visual fixations in response to outcomes that conflicted with, rather than matched, the emotional expression in question. Instead, infants treated the Desire-Emotion follow-up task as they do intermodal tasks, in which visual displays are paired with related sounds (Spelke, 1985). Just as infants are inclined to look at the images that relate to an accompanying sound, in the present study they were found to look at the outcome image that matched the emotional expression being displayed.

Unfortunately, we were not able to replicate this pattern of results in the analysis of control trials. One possible explanation of this finding is that children had object preferences. However, when object preferences were assessed using a very lenient criterion, only about half the children showed response patterns consistent with having object preferences. Furthermore, the pattern of null results obtained on the control trials may be explained in other ways. For example, inferior performance on the control trials may have been due to fatigue, given that these trials always occurred at the end of the experiment, following the standard trials for both tasks. In support of this explanation, children's mean fixation to test stimuli during the standard trials (collapsing across conditions) was significantly lower than it was for the two control trials combined.

A final possibility is that children were unable to succeed on this set of trials due to their inability to monitor the protagonist's current desire. To the extent that children recalled the actress' desired object in the standard trial at the time of the control trials, confusion may have arisen when the actress expressed a desire for the other object in the object pair. In the face of such conflicting information, children may have either discounted the desire information presented in the control trials, or have concluded that the actress liked both objects in an object pair. In either case, children's performance would be adversely affected.

CHAPTER FOUR: GENERAL DISCUSSION

The purpose of the present series of experiments was to examine young children's understanding of specific mind-world and mind-mind connections. Experiment 1 assessed the understanding that knowledge may be acquired through visual perception, and that surprised reactions occur when a person's expectation or knowledge state is violated. Experiments 2 and 3 examined the understanding that emotional reactions are related to a person's pre-existing desires, and the understanding that desires guide human actions. Of interest was whether infants would demonstrate understanding of these relationships between 18 and 30 months of age.

Because the tasks included in this study measured children's knowledge of two types of mental states, beliefs and desires, it was possible to test a major hypothesis associated with the Theory theory which is that desire understanding precedes belief understanding developmentally. We were also able to test the hypothesis that most children under 3 years of age operate without any conception of beliefs (Wellman, 1993; Wellman & Woolley, 1990). Given previous work suggesting a lag between children's understanding of desires and beliefs, it was expected that children's performance on the desire tasks would exceed their performance on the beliefs tasks. Also of interest was whether children would pass the tasks of Experiment 1, since without a concept of beliefs, they should not be able to pass either task.

Understanding of the Perception-Knowledge Relationship

In Experiment 1, children's understanding of visual perception as a knowledge acquisition device was assessed using an adaptation of the preferential looking technique, a method that places minimal task demands on the young child. The results of this task failed to demonstate an understanding of the link between seeing and knowing in any of the age groups tested. One possible explanation for children's failure on the Perception-Knowledge task is that they do not appreciate that knowledge may be acquired by means of visual perception. While possibly true of 18- and 24-month-olds, this explanation is unlikely to account for the 30-month-olds' performance, since children this age show some ability to infer knowledge status from visual access information in helpseeking tasks (e.g., Pillow & Brownell, 1991).

Another possibility is that 18- to 30-month-old children do not typically consider another person's knowledge state unless they have a motive or personal stake in doing so. In contrast to the Pillow and Brownell's study, children in the present study had no special incentive for considering the protagonist's knowledge state, and therefore may not have been able to access this information as readily. This explanation gains support from the finding that preschool children show understanding of certain mental states (e.g., false beliefs) when provided with a motive for considering the mental state of another person, but fail to demonstrate this understanding in other contexts (Hala & Chandler, 1994).

Alternative accounts of children's failure on this task have to do with certain methodological features of the task. As discussed earlier, it is possible that young children understand that seeing leads to knowing, but were unable to demonstrate this due to the memory requirements of the task, or because the dependent measure used (cumulative looking time) lacked the sensitivity needed to detect this understanding. In future studies, it would be helpful to include some memory control trials in order to ascertain, for example, whether children recalled the location of the hidden object. Given these aspects of the task, it is difficult to decide at present among these different interpretations. However, it is certainly premature to conclude that children of the ages tested in our study do not understand that seeing and knowing are linked.

In designing the Perception-Knowledge task of Experiment 1, we were initially interested in answering questions about young children's understanding of the causal relationship between seeing and knowing. However, as mentioned in the introduction, it has been suggested that children may begin with an associative understanding of the perception-knowledge link and only later, around 4 years, arrive at a causal view of this relationship (O'Neill, Astington & Flavell, 1992). Consistent with this hypothesis, there is evidence that 3-year-olds do not understand which kinds of knowledge are available through specific perceptual modalities, and are unable to explain how they know something (Gopnik & Graf, 1988; O'Neill et al, 1992; Povinelli & DeBlois, 1992). Furthermore, it appears that young children's grasp of the perception-knowledge link is more advanced for some modalities (especially visual perception) than for others (e.g., O'Neill et al, 1992; Pillow, 1993). Nevertheless, 3-year-olds do seem to appreciate that perceptual access, and not simple proximity, is required to have knowledge of an object's properties (Pillow, 1993).

One of the important implications of these findings is that previous reports of success on knowledge assessment tasks by 3-year-olds (e.g., Pillow, 1989; Pratt & Bryant, 1990) may not reflect a general understanding of the causal relationship between perceptual access and knowledge, since understanding of the perception-knowledge link may be limited to the modality of visual perception at this age. Moreover, it is possible that children's success on visual access tasks is based on a crude assessment as to whether the person or puppet had had any kind of perceptual access to the object at all, and not on a true understanding of how visual perception can function as a causal origin of certain kinds of knowledge. Therefore, it is not possible to say at present whether children's initial understanding of the perception-knowledge relationship is best characterized as associative or causal.

If future research confirms the hypothesis that children's initial understanding of the perception-knowledge relationship is actually associative rather than causal, this will have important implications for the Theory theory, in which children's conceptions of the mind are viewed as theoretical in part because they form a causal-explanatory framework. An associative understanding of the link between perception and knowledge would be more in keeping with a script-based account of children's knowledge of the mind (see Astington & Gopnik, 1991a, for a description of this account), which holds that children's psychological knowledge consists of an accumulation of rough empirical generalizations, as opposed to a coherent theory with explanatory constructs. In the end, it may emerge that both accounts are relevant at different points in development. For example, it is possible that children acquire an associative understanding of the perception-knowledge relationship that serves as a foundation for a later-acquired theoretical understanding of this link (Pillow, 1993).

Understanding of Belief-Dependent Emotions

The purpose of the Belief-Emotion task in Experiment 1 was to investigate toddlers' understanding of the mediating role of beliefs, and specifically knowledge, in other people's emotional reactions. The results of this task failed to support this kind of understanding in the age range tested. Since no one has specifically assessed understanding of belief-dependent emotions in children under 3 years of age, the null findings on this task do not conflict with previous research findings.

One account for the obtained results is that young children simply do not recognize that emotional reactions such as surprise are shaped by a person's beliefs. In support of this interpretation, there is previous work showing that even preschool-aged children have difficulty relating surprised reactions to a person's beliefs on emotion-prediction tasks (Hadwin & Perner, 1991), a finding that is usually explained in terms of preschoolers' general difficulty with false beliefs. In addition, there is evidence that children initially possess a limited and largely incorrect notion of what the word "surprise" means, either viewing it as a gift or a reaction to the presentation of desirable objects, rather than a psychological state occurring in response to belief violations (McLaren & Olson, 1993; Wellman, Harris, Banerjee, & Sinclair, 1995).

In spite of these negative findings, we hypothesized that preschoolers' previous failure to demonstrate understanding of belief-dependent emotions may have been due to methodological factors, as opposed to a genuine lack of understanding. For example, there is evidence that emotion-prediction tasks are not the most sensitive measure for assessing emotional understanding. Furthermore, the tendency to associate the word "surprise" with positive events is not restricted to children (Wellman & Banerjee, 1991; Wellman, Harris, Banerjee, & Sinclair, 1995), and does not preclude the possibility that children attach other meanings to this word as well. Even if children do have difficulty comprehending surprised reactions, this may not be related to problems with belief understanding. Rather, it may have to do with the fact that, unlike happy and sad reactions, surprise often occurs as part of a blend of two emotions, such as a blend of fear and surprise, or happiness and surprise (Baron-Cohen, Spitz & Cross, 1993).

The most plausible explanation for children's failure on the Belief-Emotion task of Experiment 1 is their unanticipated bias for the surprised face, which resulted in longer visual fixations to the surprised face across both event conditions (expected and unexpected). Because understanding was assessed by comparing visual fixations to the two test screens, the bias toward the surprised face diminished the likelihood of obtaining the predicted interaction between emotional reaction and event type. This bias was found to diminish with age, but was still present at 30 months, the oldest age group tested. Special interest in surprised faces was reported in one previous study involving much younger infants, suggesting that this interest may be present over a long period in early development (Serrano et al., 1992).

At present, an explanation for the salience effect involving the surprised face is difficult to specify. However, a novelty effect seems plausible. The surprised expressions used as stimuli in the Belief-Emotion task consisted of static and prolonged facial expressions of high intensity. Moreover, surprised expressions were pure, in the sense that they did not include featural aspects of other emotional states. According to Termine and Izard (1988), surprise is not frequently posed in isolation in infant-caregiver interactions, but occurs more often as part of a blended expression (e.g., "mock surprise," which is a blend of happy and surprise). Thus it is possible that infants were particularly interested in the surprised expressions due to their relative novelty compared to the neutral expressions. Anecdotally, a number of infants were observed to imitate the surprised face during the test phase.

In summary, it is not possible to conclude whether young children possess a belief-based understanding of surprised reactions on the basis of the present findings. Even if future studies fail to confirm a mental-state based conception of surprised reactions in young children, other construals are possible which do not entail ideas about beliefs. In line with this idea, Baron-Cohen, Spitz, and Cross (1993) suggest that any emotion may be construed in a way that takes account of a person's intentional mental state ("cognitive" construal), or alternatively, in a more situation-based fashion ("simple" construal), depending on how the person observing it conceives of its current cause. This raises the possibility that young children may associate surprised reactions with specific situations or events (e.g., a loud bang) without taking account of the other person's mental state. Certainly not all surprised reactions could be understood in this manner. For example, one could not make sense of an everyday event like someone answering the door and reacting with surprise to the person there, without having some concept of how expectations impact on emotion states (Baron-Cohen et al., 1993).

In their article, Baron-Cohen et al. (1993) propose that certain emotions are typically construed in a situational-based manner (eg., happy, sad, fearful), whereas others are usually construed as cognitive (e.g., surprise, interest, embarrassment). While this may constitute an accurate analysis of adults' conceptions of these states, it is theoretically possible that children show a different pattern in which all, or most, emotions are initially understood in a situation-based way. Consistent with this proposal, there is evidence to suggest that children initially view surprise as a reaction that follows the presentation of desirable objects (McLaren & Olson, 1993). Similarly, children may be inclined to associate other people's surprised reactions with what they themselves view as unusual events, without taking account of the other person's beliefs or expectations. Supporting this possibility, one study found that nearly 50% of 3-year-olds and 40% of 2-year-olds predicted that a story character would feel surprised upon seeing her mother with pink hair (Michalson & Lewis, 1985). In summary, it is possible that "belief-dependent emotions" such as surprise are initially understood by young children in a way that does not take account of others' beliefs.

While there is no evidence to support the idea of a belief-based understanding of surprised reactions in children aged 2 and under, it is possible that toddlers and infants recognize the cognitive underpinnings of other emotional states. In other words, by focusing almost exclusively on surprised reactions, researchers may have underestimated children's grasp of the connection between beliefs or expectations and emotional states. Two "belief-dependent" emotions that may be more readily grasped by toddlers and infants are curiosity and amused reactions. Curiosity has been classified as a belief-dependent emotion, since to be curious is to be lacking in knowledge or in a belief about an outcome (Wellman & Banerjee, 1991). In one study employing an emotion-explanation method, 3- and 4-year-old children were told about a character who saw another child bring a closed bag to school for show and tell, and were asked why that character was so curious (Wellman & Banerjee, 1991). The results showed that children were just as accurate at referring to a person's knowledge status in generating explanations for curious reactions as for surprised reactions. Because the youngest children in this study were 3 years of age, infants' and toddlers' understanding of curious reactions remains an area for future investigation.

Another potentially fruitful avenue for investigators would be to conduct further research on humor production and comprehension in very young children. The reason that humor may provide a window into a child's understanding of the mind is that it often involves the recognition and purposeful manipulation of another person's expectations (St. James & Tager-Flusberg, 1994). Indeed, it has been suggested that infants' teasing behaviors show not only an understanding of expectations in other people, but also the understanding that expectations and affective responses are linked (Reddy, 1991). While non-mentalistic explanations of teasing behaviors have been proposed, there is at least some evidence to support a link between humour production and belief understanding. For example, in an observational study of humour in children with autism and Down Syndrome, autistic children produced significantly less humour overall and less humor involving nonverbal incongruity (St. James & Tager-Flusberg, 1994). It was concluded that autistic children's lack of humor may be related to their well-known difficulties understanding mental states, especially beliefs. In summary, the understanding that playful violations of another person's expectation can lead to a changed emotional state, namely amusement, in that person may precede understanding of other belief-based emotions developmentally. One possible way to assess this would be to examine longitudinal language transcripts (CHILDES) for instances in which the child ascribes an amused reaction to another person (e.g., he thinks it's funny/silly) and to see whether such attributions are made in the context of unexpected or incongruous events.

The Role of Desires in Human Action

One of the goals of this research project was to assess toddler's understanding that people's actions are guided by their desires. In the Desire-Action task of Experiment 2, this was assessed by presenting a protagonist who indicated her desire for a particular object through verbal and nonverbal cues. The results of this task were strongly supportive of an understanding of desire-dependent action at all the ages tested. Even 18-month-olds showed longer fixations to actions that were incongruent with the protagonist's desire than to desire-congruent actions on the standard trials. The analysis involving control trials provided weaker evidence, demonstrating an effect for boys only. However, the weaker results in the control analysis may be partially attributable to a fatigue effect. In addition, poorer performance on the control trials may relate to the fact that the desired object in the control trials was the reverse to what it had been in the previous standard trials, possibly confusing children about the protagonist's desire. This would be especially likely to occur if young children do not appreciate the potentially changing nature of desires.

The Desire-Action follow-up task of Experiment 3 was designed in an effort to rule out two possible interpretations of successful performance on the original task: a spatial cueing hypothesis and the relative attention hypothesis. When they were administered the follow-up task, 24-month-old children failed to show the predicted action effect, suggesting that they did not understand the connection between desires and actions. However, a more likely explanation for children's difficulty on this task concerned the reversal of the location of objects on the table (right versus left) between the information and test phase of each trial. Recall that this modification was made in an attempt to rule out a spatial cueing interpretation of task success.

However, it could easily have confused children about the identity of the desired object.

Another possible contributor to children's failure on the Desire-Action follow-up task was the manner in which the protagonist interacted with the desired and nondesired objects. In order to equalize the amount of attention accorded to each object, the protagonist looked, gestured, and commented on both objects to the same extent in the revised task. Thus, the two objects were treated in much the same manner, with the exception that the actor said she wanted the desired object (I want that one!), while simply drawing attention to the nondesired object (Look at that one!). Although the actor pointed to the desired object, and merely gestured toward the nondesired object with an open hand, infants may not have noted this or have attached special significance to the pointing gesture, although pointing was found to be a very salient desire cue in another study (Lee, Eskritt, Symons, & Muir, in press). Alternatively, it is possible that pointing and showing gestures were not easily distinguishable on the videos. Because objects were treated so similarly, children could easily have inferred that the actress liked and was interested in both objects, meaning that a subsequent action towards either object would be expected by the infant.

In conclusion, the present findings provide good evidence that children as young as 18 months of age expect people to act in accordance with their desires and/or focus of attention. That is, when given verbal and nonverbal cues about a person's desire, children seemed to expect actions consistent with those desires. In the present study, children were provided with multiple potential cues concerning the protagonist's desire, including pointing, head orientation, eye gaze, and the word "want." Because the cues were presented simultaneously, it is not clear which one(s) were most important for conveying information about the protagonist's desire. However, a recent proposal is that desire inference in young children is achieved from multiple sources of information, including nonverbal cues and verbal cues (Lee et al, in press). While our study did not address children's use of individual cues explicitly, nonverbal cues may have been of primary importance, since children failed to solve the task on the basis of the verbal cue provided ("want") when the protagonist looked and gestured equally to both objects in the follow-up task.

While it appears that 18-month-olds are able to associate desires and actions, it is not clear from the present findings whether children this age view desires as mental states that are distinct from the actions they cause. For example, it is possible that toddlers in our study expected actors to approach objects previously pointed to and gazed at on the basis of learned associations. However, this conservative interpretation of children's behavior on the task seems unlikely in light of the fact that young children differentiate desires from actions in their everyday speech (Bartsch & Wellman, 1995).

Understanding of Desire-dependent Emotions

One of the goals of the present study was to test for toddlers' understanding that emotional reactions may be mediated by a person's desires. In particular, the Desire-Emotion task of Experiment 2 assessed whether 18- to 30-month-olds expect a person to feel sad when her desire is thwarted, and happy when it is satisfied, indicating an understanding of the causal role of desires in these emotional reactions. Children failed to showed a clear understanding of this relationship in Experiment 2. However, this was explained in terms of an unanticipated bias for looking at the sad face, as opposed to a true conceptual problem. In other words, it appears that children's striking preference for looking at the sad face over the happy face served to mask their understanding. Because happy and sad faces were presented simultaneously in the test phase and children showed such overwhelming interest in the sad face, we were unable to test adequately for the expected interaction effect involving emotion and outcome.

Children's bias for looking at the sad expression was not anticipated, particularly in light of previous research showing that younger infants spend less time looking at their mothers when they pose sad expressions, or simulate depression (Termine & Izard, 1988; Tronick, Ricks, & Cohn, 1982). This apparent discrepancy may be explained in a number of different ways. Specifically, it is possible that while all infants find sad expressions interesting due to their relatively infrequent occurrence in the context of mother-infant interactions (Malatesta & Haviland, 1982; Termine & Izard, 1998), younger infants may find such expressions very stressful and show gaze aversion, whereas older children may feel less threatened when confronted with such expressions. Alternatively, it is possible that some stimulus characteristic (e.g. live versus filmed, stranger versus caregiver) accounts for this finding. A further hypothesis supported by findings in the adult literature on social processing (Hansen & Hansen, 1988; Pratto & John, 1991) is that the greater attention paid to the sad expressions by infants is mediated by attentional processes having adaptive significance. In other words, infants may come prewired, or quickly acquire, the tendency to assign more importance to sad faces than to happy or neutral faces.

In order to minimize the effect of the sad face bias on subject performance, we designed the Desire-Emotion follow-up task (Experiment 3). In the revised task, trials were redesigned so that the sad and happy facial expressions were never presented simultaneously during the test phase. This modification allowed us to examine whether children could coordinate information about desire, outcome, and facial expression, without the interfering effect of a facial expression bias. Twenty-four-month-old children performed as predicted on the standard trials of the Desire-Emotion follow-up task. Specifically, a congruency effect was obtained in which children showed longer fixations to the screen depicting a positive outcome in the happy condition, and longer fixations to the screen showing a negative outcome in the sad condition.

While we had initially predicted an incongruency effect, both congruency and incongruency effects are consistent with an understanding of desire-dependent emotion in that they differ from a chance pattern of responding. However, a congruency effect supports a slightly different interpretation than an incongruency effect. Specifically, it suggests that children responded to this task in the same way they respond to intermodal matching tasks, that is, by treating the desire-outcome-emotion sequences presented as unified events. Unfortunately, the positive findings obtained in the standard trials of the follow-up task were not replicated in the control trials of this task. This may have been partly the result of a fatigue effect, as is suggested by the fact that children attended less to the test stimuli during the final control trials than they did for the preceding standard trials. Alternatively, it is possible that children became confused about which object the protagonist desired for the same reasons as described earlier.

Relevance of the Present Findings for the Theory Theory

In summary, the results of this series of experiments are consistent with two major predictions of the theory theory: that desire understanding precedes belief understanding, and that most children under the age of 3 years operate without a conception of beliefs (Wellman, 1993; Wellman & Woolley, 1990). Concerning toddlers' understanding of desires, our results suggest an understanding of desire-based action in children as young as 18 months of age, and an understanding of desire-dependent emotion in children as young as 24-months of age. This implies that children grasp the relationship between desires and human actions and emotions even earlier than suggested by previous work (e.g., Wellman & Woolley, 1990). In contrast, no evidence was found for an understanding of how belief violations relate to surprised reactions, or for the understanding that knowledge can be acquired by means of visual perception. While this pattern of findings is consistent with the developmental sequence postulated by the Theory theory, it is premature to conclude that children under 3 years lack a concept of beliefs for the reason that failure on the tasks of Experiment 1 may be explained in a number of ways that have nothing to do with conceptual limitations on the part of the child. In summary, the findings of this study are consistent with the characterization of the young child as a desire-psychologist, but do not rule out an understanding of belief in children under 3 years.

Explaining the Lag between Desire and Belief Understanding

As already mentioned, the results of the present study did not provide any evidence for an understanding of beliefs in young children. In addition, the current findings accord with previous research in suggesting that children's understanding of beliefs lags behind their corresponding understanding of desires. Assuming this sequence is correct, this raises the question of what accounts for the greater difficulty young children have in understanding beliefs as opposed to desires. One proposal is that beliefs are more difficult to conceptualize for the reason that to do so, one must understand mental representation, which is not required in the case of simple desires (e.g., Bartsch & Wellman, 1995). According to this view, a young child does not have to construe the desirer as mentally representing an object or state of affairs, but only as having an internal subjective state of longing or desire for an external (real) object or state of affairs. In contrast, to understand beliefs properly, the child needs to construe the other person as having a representation of an external state of affairs that is independent of that external reality. Thus, beliefs may be more difficult to comprehend since they require consideration of "two sets of contents": objects in the real world and mentally represented objects.

If it is the case that beliefs can only be understood as mental representations, then this may account for why belief understanding lags behind the understanding of desires. However, there is growing speculation that both beliefs and desires may be understood initially in a nonrepresentational manner (e.g., Flavell, 1988; Perner, 1991). For example, Perner (1991) has proposed that children may initially construe knowledge as a "potential for correct action" before they understand it as mental representation. If this is true, then one cannot explain the observed developmental sequence for belief and desire understanding in terms of a distinction between representational versus nonrepresentational mental states.

An alternative account for the developmental lag in belief understanding was suggested by Harris (1996). Harris proposed that a critical precondition for the understanding of beliefs is participation in the exchange of information through conversation, which is not typically attained until the age of 3, due to the verbal limitations of younger children. Involvement in conversations with others is considered important since it helps to demonstrate differences in what conversation partners know and believe about a common topic. In theory, exposure to a differing beliefs obtained through verbal exchange enables the child to overcome his initial incorrect assumption that other people share the child's own beliefs about a situation. While Harris is able to list some findings supporting this view (Harris, 1996), he seems to underestimate the amount of information about a person's beliefs that might be conveyed nonverbally. For example, if one were to see two people headed out the door, one wearing a winter coat and the other in shorts, he might infer that these two individuals had different beliefs concerning the temperature outside.

A third possibility is that the lag is either illusory, or that the proposed timing of this lag is incorrect. In this view, the current portrayal of 2-year-olds as desire-psychologists is simply incorrect, meaning that one cannot really speak of a major theory change as occurring between the ages of 2 and 4 years. Supporting this idea, 2-year-olds have shown an ability to take account of belief information when predicting a character's future actions when a nonverbal indicator of understanding (anticipatory looking) was used (Clements & Perner, 1994). Furthermore, 2-year-olds appear to understand something about the relationship between visual perception and knowledge, since they can use information about past visual access to an event in order to choose the best helper in the context of a help-seeking task (Pillow & Brownell, 1991). However, even if 2-year-olds do attribute and understand beliefs as is suggested by these findings, it remains possible that children operate without a conception of beliefs at some time prior to the age of 2 years.

Future Directions for Research on the Causal Aspect of Mind

Based on the present series of studies a number of suggestions can be made concerning future use of this adaptation of the preferential looking technique. As discussed earlier, some advantage may accrue to the use of additional dependent measures, such as longest look and first look, due to the possibly greater sensitivity of these measures. Generally speaking, one should endeavor to minimize the memory demands and, if possible, include memory controls in order to ensure that children are processing tasks in the intended manner. If children's emotional understanding is to be investigated using the current method, it will be necessary to address certain methodological factors, such as the relative salience of different facial expressions for young children. In order to do this effectively, it would be useful to conduct research aimed at discovering what these preferences are, and what they mean. Additionally, it would be preferable to employ different emotional cues (e.g., facial expression and vocal expressions) when investigating young children's emotional understanding, since some cues may be more readily understood by infants than others. Relevant to this issue, there is evidence that infants may be more influenced by vocal information than facial information when each occurs separately (Mumme, Fernald, & Herrera, 1996). Finally, given that young children appear to do better in tasks where they are provided with a motive for considering another person's mental state, the present adaptation of the preferential looking paradigm may not be the most sensitive test of mental-state understanding in young children. For this reason other standardized assessment procedures should also be considered.

Concerning future studies on children's emotional understanding, it appears that the designation of certain emotions as "belief-dependent" and others as "desire-dependent" needs substantial modification in order to deal with a variety of issues. As discussed earlier, it is possible that children may initially construe all or most emotions in a situation-based manner that does not involve the attribution of desires or beliefs to the other person. Thus, it is important to consider the possibility of a situation-based construal and a mental-state based construal of the same emotion (e.g., Baron-Cohen et al., 1993). Moreover, it seems that many emotional reactions are based both on a person's desires and beliefs, raising questions about the utility of this distinction. Curiosity, for example, which was considered a belief-dependent emotion in one study (Wellman & Banarjee, 1991), reflects more than a simple lack of knowledge, since a person may lack knowledge of an object or event but remain uncurious about it. Instead, curiosity seems to reveal an underlying desire for information which is considered valuable. To date, research evaluating children's understanding of the link between beliefs and emotions has centered on children's understanding of surprised reactions. This focus should be extended to other less studied emotions thought to involve a belief-component, such as curiosity, interest, and amusement, so as to achieve a wider perspective on understanding of these reactions.

In designing future studies, another important question to consider is whether one is actually measuring causal understanding, or a simpler associative type of understanding instead (O'Neill et al., 1992). In order to address this issue, researchers need to be more explicit about how "causal" understanding of a relationship is to be defined. For example, one might be referring to the child's understanding of a set of logical conditions (e.g., that X is necessary for Y to occur). Alternatively one might be ascribing an understanding of "generative transmission," the understanding that a specific cause brings about the obtained effect via some form of transmission (Shultz, 1982). The latter definition is preferable for the reason that it is more easily distinguished from associations based on temporal or spatial contiguity, for example.

A further question concerns the means by which one might differentiate between associative and causal understanding of a specific relationship. One indication that children possess a causal understanding of a relationship is their ability to describe, or demonstrate nonverbally, an understanding of how an effect was achieved. For example, in the case of knowledge acquisition they should be able to state, or demonstrate in some other way, that people gain knowledge of an object's colour by seeing the object. In evaluating young children's understanding of mind-world and mind-mind connections involving beliefs and desires, it is important to demonstrate that children are in fact attributing internal subjective mental states to the other person, and not simply associating certain behavioral cues (e.g., pointing, gazing, or smiling at an object) with certain actions (e.g. grasping or reaching for the object). Thus, more needs to be known about the ontological aspect of mind in infancy. In addition, it is important to explore the age at which infants might construe of mental states as being distinct from the actions and emotions they cause. For if infants do not distinguish cause and effect, then one cannot describe their knowledge as causal.

In the present study, children were given behavioral cues concerning a person's mental state, thus it is possible that their successful performance on some tasks reflects a simple association between certain nonverbal cues and certain behavioral dispositions. For instance, children may have succeeded on the Desire-Action task of Experiment 2 because they expect people to act on objects that they have previously pointed at, without attributing desires to that individual. While this is possible, it seems unlikely given previous work suggesting that 2-year-olds understand the subjective nature of desires (Bartsch & Wellman, 1995).

In examining children's understanding of the various mind-mind and mind-world linkages discussed (e.g., the relation between perception and knowledge), one cannot assume that such linkages are attained in an all-or-none manner. Indeed, there is evidence to suggest that children understand the perception-knowledge link for visual perception before such a link for other perceptual modalities, such as hearing and touch. Moreover, as proposed earlier, it may be that certain belief-dependent emotions like curiosity or interest are understood before other belief-dependent emotions like surprise. For this reason, it would be helpful to compare understanding of different emotions, or different perceptual modalities, within the same task. Even if infants' initial conceptions of the mind-mind and mind-world linkages are not genuinely causal, it is still interesting to discover the kinds of associations that they do appreciate. For example, one might investigate the age at which infants associate various perceptual activities (e.g., seeing and listening) with knowledge of an object's specific properties (e.g., color and sound) by using dolls that possess or do not possess the necessary perceptual organs.

Summary and Conclusions

In summary, the purpose of the present series of experiments was to examine 18- to 30-month-old children's understanding of what has been referred to as the causal aspect of mind. In particular, children's knowledge of several relationships involving beliefs and desires was examined using an adaptation of the preferential looking paradigm. The results obtained are consistent with the desire-psychologist characterization of toddlers posited by the Theory theory (Wellman, 1993). Whereas understanding of the perception-knowledge relationship and the belief-emotion relationship was not found in any of the age groups tested, understanding of the relationship between desires and actions was demonstrated in children as young as 18 months. In addition, 24-months olds showed an appreciation of how desires shape the emotional reactions of happy and sad. Given children's bias for the surprised face in the Belief-Emotion task and the possibly excessive task demands of the Perception-Knowledge task, it is not possible to conclude on the basis of the present study that toddlers in the age range tested do not understand something about how beliefs shape emotions and about the manner in which beliefs are generated.

REFERENCES

Astington, J. & Gopnik, A. (1991a). Theoretical explanations of children's understanding of the mind. British Journal of Developmental Psychology, 9, 7-31.

Astington, J. & Gopnik, A. (1991b). Developing understanding of desire and intention. In A. Whiten (Ed.), Natural theories of mind: The evolution, development and simulation of everyday mindreading (pp. 39-50). Oxford: Basil Blackwell.

Astington, J.W., Harris, P.L., & Olson, D.R. (1988). Developing theories of mind. Cambridge: Cambridge University Press.

Baldwin, D. & Moses, L. (1994). Early understanding of referential intent and attentional focus: Evidence from language and emotion. In Lewis & Mitchell (Eds.), Children's early understanding of mind: Origins and development (pp. 133-156). Hilldale, NJ: Erlbaum.

Barden, C., Zelko, F., Duncan, W. & Masters, J. (1980). Children's consensual knowledge about the experiential determinants of emotion. Journal of Personality and Social Psychology, 39(5), 968-976.

Baron-Cohen, S. (1991). Precursors to a theory of mind: Understanding attention in others. In A. Whiten (Ed.), Natural theories of mind: The evolution, development and simulation of everyday mindreading (pp. 233-253). Oxford: Basil Blackwell.

Baron-Cohen, S. (1993). From attention-goal psychology to belief-desire psychology: the development of a theory of mind, and its dysfunction. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), Understanding other minds: Perspectives from autism, (pp. 59-82). Oxford: Oxford University Press.

Baron-Cohen, S., Spitz, A. & Cross, P. (1993). Do children with autism recognize surprise? A research note. Cognition and Emotion, 7(6), 507-516.

Bartsch, K. (1996). Between desires and beliefs: Young children's action predictions. Child Development, 67, 1671-1685.

Bartsch, K. & Estes, D. (1997). Children's and adults' everyday talk about surprise. British Journal of Developmental Psychology, 15, 461-475.

Bartsch & Wellman (1989). Young children's attribution of action to beliefs and desires. Child Development, 60, 946-964.

Bartsch, K. & Wellman, H. (1995). Children talk about the mind. New York: Oxford University Press.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L. & Volterra, V. (1979). The emergence of symbols: Cognition and communication in infancy. New York: Academic Press.

Borke, H. (1971). Interpersonal perception of young children: Egocentrism or empathy? Developmental Psychology, 5, 262-269.

Bratman, M. (1984). Two faces of intention. Philosophical Review, 93, 375-405.

Bretherton, I. & Beeghly, M. (1982). Talking about internal states: The acquisition of an explicit theory of mind. Developmental Psychology, 18, 906-921.

Bretherton, I., McNew, S., & Beeghly-Smith, M. (1981). Early person knowledge as expressed in gestural and verbal communication: When do infants acquire a "Theory of Mind"? In M. E. Lamb & L.R. Sherrod (Eds.), Infant social cognition (pp. 333-373). Hillsdale, NJ: Lawrence Erlbaum.

Carpenter, M., Akhtar, N. & Tomasello, M. (1996, April). Understanding of intentional versus accidental actions in 14- to 18-month-old infants. Poster presented at the International Conference on Infant Studies, Providence, R.I.

Carruthers, P. & Smith, P. (1996). Theories of theories of mind. Cambridge, NY: Cambridge University Press.

Chandler, M. & Hala, S. (1994). The role of personal involvement in the assessment of early false-belief skills. In C. Lewis & P. Mitchell (Eds.), Origins of an understanding of mind (pp. 403 - 426). Hove: Erlbaum.

Clements, W. & Perner, J. (1994). Implicit understanding of belief. Cognitive Development, 9, 377-395.

Dunn, J. (1991) Understanding others: Evidence from naturalistic studies of children. In A. Whiten (Ed.), Natural theories of mind. Oxford: Basil Blackwell.

Ekman, P. (1984). Expression and the nature of emotion. In K. S. Scherer & P. Ekman (Eds.), Approaches to emotion (pp. 319-343). Hillsdale, N.J.: Erlbaum.

Ellsworth, C. P., Muir, D. W., & Hains, S.M. (1993). Social competence and person/object differentiation: An analysis of the still-face effect. Developmental Psychology, 29(1), 63-73.

Estes, D., Wellman, H.M. & Woolley, J.D. (1989). Children's understanding of mental phenomena. In H. Reese (Ed.), Advances in child development and behavior. New York: Academic Press.

Flavell, J.H. (1988). From cognitive connections to mental representations. In J. Astington, P. Harris, & D. Olson (Eds.), Developing Theories of Mind, (pp. 244-270). Cambridge University Press: New York.

Flavell, J., Everett, B., Croft, K. & Flavell, E. (1981) Developmental Psychology, 17(1), 99-103.

Flavell, J., Flavell, E., Green, F. & Moses, L. (1990), 61, 915-928. Young children's understanding of fact beliefs versus value beliefs. Child Development, 61, 915-928.

Franco, F. & Butterworth, G. (1996). Pointing and social awareness: Declaring and requesting in the second year. Journal of Child Language, 23(2), 307-336.

Gopnik, A. & Astington, J. W. (1988). Children's understanding of representational change and its relation to understanding of false belief and the appearance-reality distinction. Child Development, 59, 26-37.

Gopnik, A. & Meltzoff, A. (1997). The child's theory of action. In Words, thoughts, and theories. Cambridge, MA: MIT Press.

Gopnik, A. & Graf, P. (1988). Knowing how you know: Young children's ability to identify and remember the sources of their beliefs. Child Development, 59, 1366-1371.

Gopnik, A. & Wellman, H.M. (1994). The theory theory. In L. Hirschfeld & S. Gelman (Eds.), Mapping the mind: Domain specificity in cognition and culture (pp. 257-293). Cambridge: Cambridge University Press.

Hadwin, J., & Perner, J. (1991). Pleased and surprised: Children's cognitive theory of emotion. British Journal of Developmental Psychology, 9, 215-234.

Hala, S. & Chandler, M. (1996). The role of strategic planning in accessing false-belief understanding. Child Development, 67, 2948-2966.

Hansen, C. H. & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. Journal of Personality and Social Psychology, 54(6), 917-924.

Harris, P. (1989). Children and Emotion. Oxford: Basil Blackwell.

Harris, P. (1991). The work of the imagination. In A. Whiten (Ed.), Natural theories of mind: Evolution, development, and simulation of everyday mindreading (pp. 283-304). Cambridge, MA: Basil Blackwell.

Harris, P. (1996). Desires, beliefs, and language. In P. Carruthers & P. Smith (Eds.), Theories of theories of mind (pp. 201-220). Cambridge: Cambridge University Press.

Harris, P., Johnson, C., Hutton, D., Andrews, G. & Cooke, T. (1989). Young children's theory of mind and emotion. Cognition and Emotion, 3(4), 379-400.

Harris, P.L., Brown, E., Marriot, C., Whithall, S. & Harmer, S. (1991). Monsters, ghosts and witches: testing the limits of the fantasy-reality distinction in young children. British Journal of Developmental Psychology, 9, 105 - 23.

Hobson (1993). Understanding persons: The role of affect. In S. Baron-Cohen, H. Tager-Flusberg, D. Cohen & Volman (Eds.), Understanding other minds: Perspectives from autism (pp. 204-227). Oxford: Oxford University Press.

Hogrefe, G., Wimmer, H. & Perner, J. (1986) Ignorance versus false Belief: A developmental lag in attribution of epistemic states. Child Development, 57, 567-582.

Hornick, R., Risenhoover, N. & Gunnar, M. (1987). The effects of maternal positive, neutral, and negative affective communications on infant responses to new toys. Child Development, 58, 937-944.

Huttenlocher, J. & Smiley, P. (1990). Emerging notions of persons. In N. Stein, B. Leventhal & T. Trabasso (Eds.), Psychological and biological approaches to emotion. Hillsdale, N.J.: Erlbaum.

Izard, C. E. (1977). Human emotions. New York: Plenum Press.

Kuhn, T. S. (1962). The structure of scientific revolutions. Chicago: Chicago University Press.

Lee, K., Eskritt, M., Symons, L. & Muir, D. (in press). Children's use of triadic eye gaze information for "mind reading". Developmental Psychology.

Lempers, J.D., Flavell, E.R., and Flavell, J. H. (1977). The development in very young children of tacit knowledge concerning visual perception. Genetic Psychology Monographs, 95, 3-53.

Leslie, A. M. (1987). Pretense and representation: The origins of 'theory of mind'. Psychological Review, 94, 412-426.

Leslie, A. M. (1988). Some implications of pretense for mechanisms underlying the child's theory of mind. In J. Astington, P. L. Harris & D. R. Olson (Eds.), Developing Theories of Mind (pp. 19-46). New York: Cambridge University Press.

Lewis, C. & Mitchell, P. (Eds.) (1994). Children's early understanding of the mind: Origins and development. Hove, East Sussex: Erlbaum.

MacLaren, R. & Olsen, D. (1993). Trick or treat: Children's understanding of surprise. Cognitive Development, 8, 27-46.

Malatesta, C. Z. & Haviland, J. M. (1982). Learning display rules: The socialization of emotion expression in infancy. Child Development, 53, 991-1003.

Masur, E.F. (1983). Gestural development, dual-directional signaling, and the transition to words. Journal of Psycholinguistic Research, 12, 93-109.

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. Developmental Psychology, 31, 838-850.

Michalson, L. & Lewis, M. (1985). What do children know about emotions and when do they know it? In M. Lewis & C. Saarni (Eds.), The socialization of emotions (pp. 117-139). New York, NY: Plenum Press.

Moses, L. & Flavell, J. H. (1990). Inferring false beliefs from actions and reactions. Child Development, 61(4), 929-945.

Moses, L., Coon, J., & Wusinich, N. (in press). Young children's understanding of the origins of desire.

Mumme, D. L., Fernald, A. & Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. Child Development, 67, 3219-3237.

Naigles, L. G. & Kako, E. T. (1993). First contact in verb acquisition: Defining a role for syntax. Child Development, 64(6), 1665-1687.

Nelson, L. A. (1987). The recognition of facial expressions in the first two years of life: Mechanisms of development. Child Development, 58, 889-909.

O'Neill, D., (1996). Two-year-old children's sensitivity to a parent's knowledge state when making requests. Child Development, 67, 659-677.

O'Neill, D., Astington, J., & Flavell, J. (1992). Young children's understanding of the role that sensory experiences play in knowledge acquisition. Child Development, 63, 474-490.

Perner, J. (1991). Understanding the representational mind. Cambridge, MA: Bradford Books/MIT Press.

Perner, J., Leekam, S. & Wimmer, H. (1987). Three year olds difficulty with false belief: The case for a conceptual deficit. British Journal of Developmental Psychology, 5, 125-137.

Phillips, W., Baron-Cohen, S. & Rutter, M. (1992). The role of eye contact in goal detection: Evidence from normal infants and children with autism or mental handicap. Development & Psychopathology, 4, 375-383.

Piaget, J. (1929). The child's conception of the world. New York: Harcourt, Brace.

Pillow, B., (1989). Early understanding of perception as a source of knowledge. Journal of Experimental Child Psychology, 47, 116-129.

Pillow, B. (1993). Preschool children's understanding of the relationship between modality of perceptual access and knowledge of perceptual properties. British Journal of Developmental Psychology, 11, 371-389.

Pillow, B., & Brownell, C.A. (1991, April). Two year old's understanding of the connection between perception and knowledge: Evidence from help seeking behaviour. Paper presented at the Society for Research in Child Development, Seattle, Washington.

Poulin-Dubois, D. (in press). Infants' distinction between animate and inanimate objects: The origins of naive psychology. To appear in P. Rochat (Ed.), Early Social Cognition. Hillsdale, N.J.: Lawrence Erlbaum.

Poulin-Dubois, D. & McKoy, K. (1998). Understanding of the subjectivity of desires in 18-month-olds. Unpublished raw data.

Poulin-Dubois, D., Serbin, L. A., Kenyon, B., & Derbyshire, A. (1994). Infants' intermodal knowledge about gender. Developmental Psychology, 30, 436-442.

Povinelli, D.J. & deBlois, S. (1992). Young Children's (Homo sapiens) understanding of knowledge formation in themselves and others. Journal of Comparative Psychology, 106 (3), 228-238.

Povinelli D.J. & Eddy, T.J. (1996). What young chimpanzees know about seeing. Monographs of the Society for Research in Child Development, 61(3, Serial No. 247).

Pratt, C., & Bryant, P. (1990). Young Children understand that looking leads to knowing (so long as they are looking into a single barrel). Child Development, 61, 973-982.

Pratto, F. & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. Journal of Personality and Social Psychology, 61(3), 380-391.

Premack, D. (1990). The infant's theory of self-propelled objects. Cognition, 36, 1-16.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? Behavioral and Brain Sciences, 1(4), 515-526.

Reddy, V. (1991). Playing with others' expectations: Teasing and mucking about in the first year. In A. Whiten (Ed.), Natural theories of mind. Oxford: Basil Blackwell.

Repacholi, B.M. & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. Developmental Psychology, 33, 12-21.

Reznick, J. S. (1990). Visual preference as a test of infant word comprehension. Applied Psycholinguistics, 11, 145-166.

Reznick, J. S. & Goldfield, B. A. (1992). Rapid change in lexical development in comprehension and production. Developmental Psychology, 28, 406-413.

Ridgeway, D., Waters, E. & Kuczaj, S. A. (1985). The acquisition of emotion-descriptive language: Receptive and productive vocabulary norms for ages 18 months to 6 years. Developmental Psychology, 21, 901-908.

Ruffman, T. & Keenan, T. R. (1996). The belief-based emotion of surprise: The case for a lag in understanding relative to false belief. Developmental Psychology, 32(1), 40-49.

Schafer, G. & Plunkett, K. (1998). Rapid word learning by 15-month-olds under tightly controlled conditions. Child Development, 69(2), 309-320.

Searle, J. R. (1983). Intentionality. New York: Cambridge University Press.

Schult, C.A. & Wellman, H.M. (1997). Explaining human movements and actions: Children's understanding of the limits of psychological explanation. Cognition, 62(3), 291-324.

Serrano, J. M., Iglesias, J., & Loeches, Angela (1992). Visual discrimination and recognition of facial expressions of anger, fear, and surprise in 4- to 6-month-old infants. Developmental Psychobiology, 25(6), 411-425.

Shaver, P., Schwartz, J., Kirson, D., & O'Connor, C. (1987). Emotion knowledge: Further exploration of a prototype approach. Journal of Personality and Social Psychology, 52(6), 1061-1086.

Shultz, T. R. (1982). Rules of causal attribution. Monographs of the Society for Research in Child Development, 47 (1, Serial No. 194).

Smiley, P. & Huttenlocher, J. (1989). Young children's acquistion of emotion concepts. In C. Saarni & P. Harris (Eds.), Children's Understanding of Emotion (pp. 27-49). New York: Cambridge University Press.

Sorce, J.F., Emde, R.N., Campos, J. & Klinnert, M.D. (1985). Maternal emotional signalling: its effect on the visual cliff behavior of 1-year-olds. Developmental Psychology, 21, 195-200.

Spelke, E. (1985). Preferential-looking methods as tools for the study of cognition in infancy. In G. Gottlieb, N.A. Krasnegor (Eds.), Measurement of audition and vision in the first year of postnatal life: A methodological overview. Norwood, NJ: Ablex Publishing.

Spelke, E., Phillips, A. & Woodward, A. (1995). Infants' knowledge of object motion and human action. In D. Sperber, D. Premack & A. Premack (Eds.), Causal cognition: A multidisciplinary debate (p. 44-78).

Stein, N. & Levine, L. (1989). The causal organisation of emotional knowledge: A developmental study. Cognition and Emotion, 3(4), 343-378.

St. James, P. & Tager-Flusberg, H. (1994). An observational study of humor in autism and Down syndrome. Journal of Autism and Developmental Disorders, 24(5), 603-617.

Tabachnick, B.G. & Fidell, L. S. (1989). Using multivariate statistics. (second edition). New York: Harper Collins.

Termine, N., & Izard, C. (1988). Infants' responses to their mothers' expressions of joy and sadness. Developmental Psychology, 24(2), 223-229.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore and P. Dunham (Eds.), Joint attention: Its origins and role in development. Hillsdale, NJ: Erlbaum.

Tomasello, M. & Barton, M. (1994). Learning words in nonostensive contexts. Developmental Psychology, 30(5), 639-650.

Trabasso, T., Stein, N. & Johnson, L. (1981). Children's knowledge of events: A causal analysis of story structure. In G. Bower (Ed.), The psychology of learning and motivation (pp. 237-282). New York: Academic Press.

Trevarthen, C. (1979). Instincts for human understanding and for cultural cooperation: Development in infancy. In M. von Cranach, K. Foppa, W. Lepenies, & D. Ploog (Eds.), Human ethology: Claims and limits of a new discipline. Cambridge: Cambridge University Press.

Tronick, E. Z., Ricks, M., & Cohn, J. F. (1982). Maternal and infant affective exchanges: Patterns of adaptation. In T. Field & A. Fogel (Eds.), Emotion and early interaction (pp. 83-100). Hillsdale, NJ: Erlbaum.

Wellman, H. (1990) The child's theory of mind. Cambridge, MA: MIT Press/Bradford Books.

Wellman, H.M., (1991). From desires to beliefs: Acquisition of a theory of mind. In A. Whiten (Ed.), Natural theories of mind: Evolution, development and simulation of everyday mindreading. Oxford: Basil Blackwell.

Wellman, H. M. (1993). Early understanding of mind: The normal case. In S. Baron-Cohen, H. Tager-Flusberg, D. Cohen & Volman (Eds.), Understanding other minds: Perspectives from autism. Oxford: Oxford University Press.

Wellman, H.M., & Banarjee, M., (1991). Mind and emotion: Children's understanding of the emotional consequences of beliefs and desires. British Journal of Developmental Psychology, 9, 191-214.

Wellman, H.M., & Bartsch, K., (1988). Young children's reasoning about beliefs, Cognition, 30, 239-277.

Wellman, H. M. & Estes, D. (1986). Early understanding of mental entities: A reexamination of childhood realism. Child Development, 57, 910-23.

Wellman, H.M., & Woolley, J.D. (1990). From simple desires to ordinary beliefs: The early development of everyday psychology. Cognition, 35, 245-275.

Wellman, H.M., Harris, P., Banerjee, M. & Sinclair, A. (1995). Early understandings of emotion: Evidence from natural language. Cognition and Emotion, 9(2-3), 117-149.

Wimmer, H. & Hartl, M. (1991). Against the Cartesian view on mind: Young children's difficulty with own false beliefs. British Journal of Developmental Psychology, 9(1), 125-138.

Wimmer, H., Hogrefe, G.J., & Perner, J., (1988). Children's understanding of informational access as a source of knowledge. Child Development, 59, 386-396.

Wimmer, H., Hogrefe, G.J., & Sodian (1988) A second stage in children's conception of mental life: Understanding informational access as origins of knowledge. In J. Astington, P. Harris, & D. Olson (Eds.), Developing Theories of Mind, (pp. 173-192).

Wimmer, H. & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. Cognition, 13, 103-128.

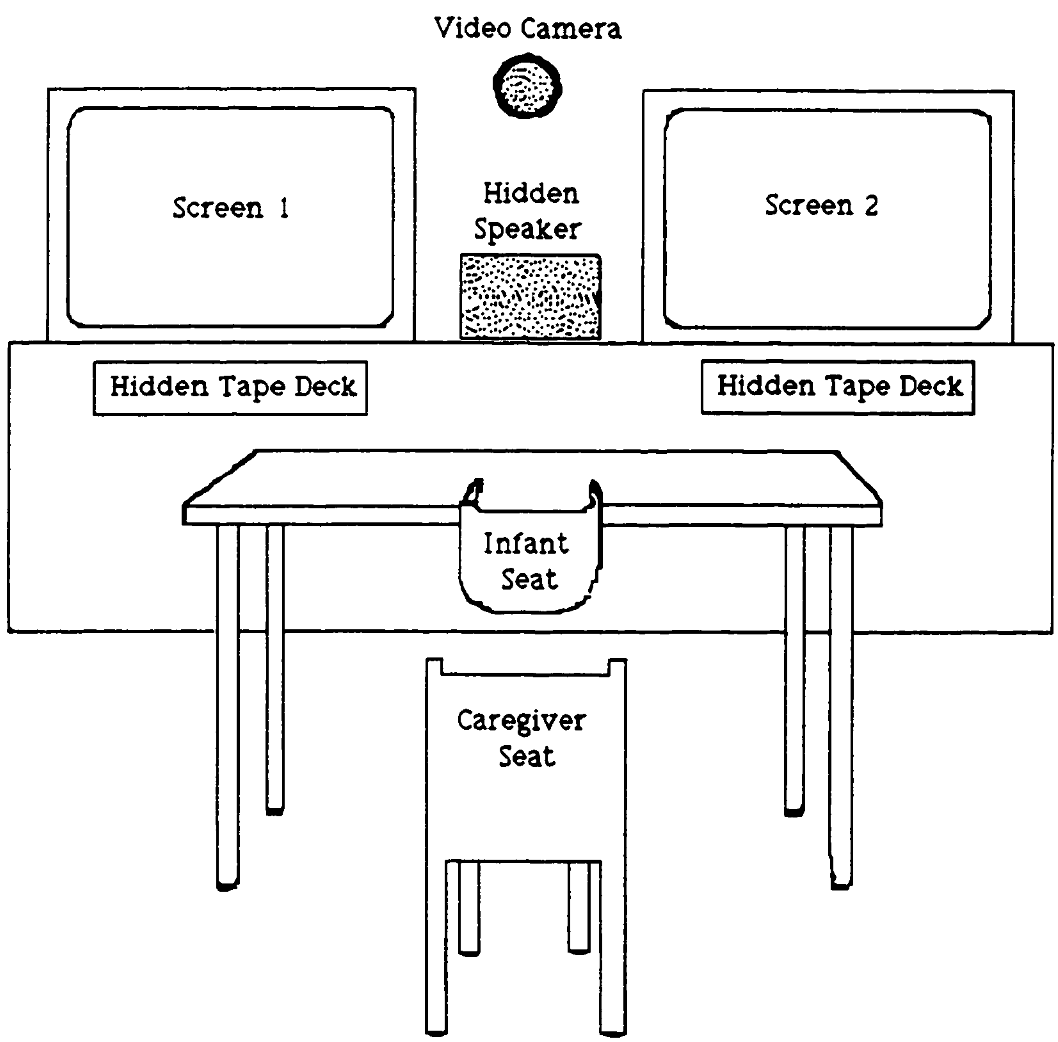
Woodward, A. (1995). Infants' reasoning about the goals of a human actor. Poster presented at the Biennial Meeting of the Society for Research in Child Development, March 1995, Indianapolis, IN.

Yuill, N. (1984). Young children's coordination of motive and outcome in judgements of satisfaction and morality. British Journal of Developmental Psychology, 2, 73-81.

Zahn-Waxler, C., Radke-Yarrow, M. & Wagner, E. (1992) Development of concern for others. Developmental Psychology, 28(1), 126-136.

Appendix A

Experimental Set Up


Video Camera
Screen 1
Hidden
Speaker
Screen 2
Hidden Tape Deck
Hidden Tape Deck
Infant
Seat
Caregiver
Seat

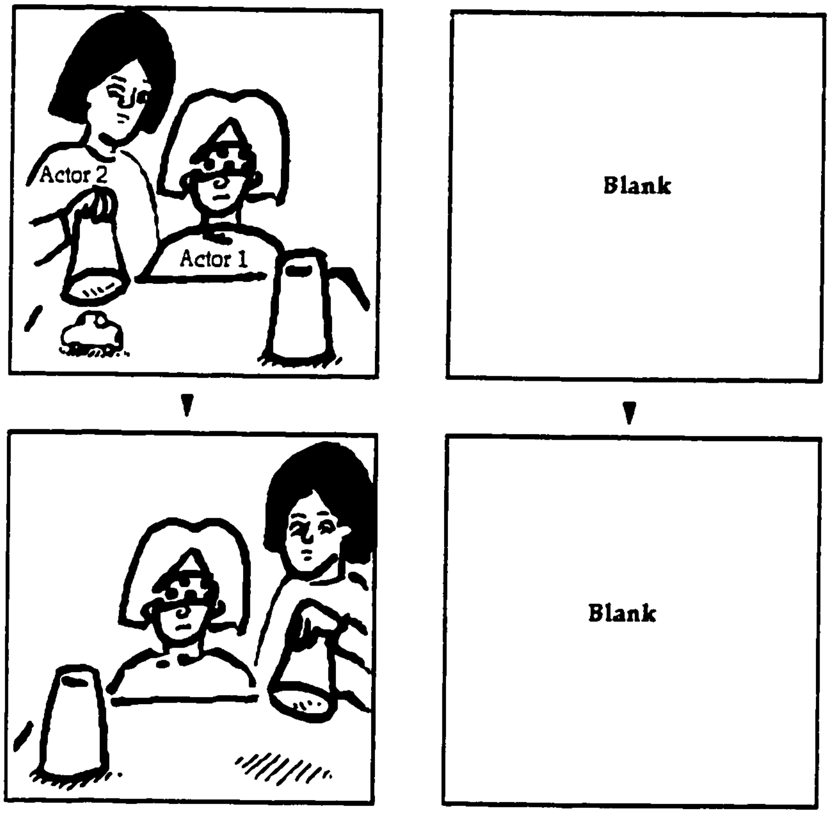
Appendix B

Schematic Representation of Stimuli used in Experiment 1

Perception-Knowledge Task: No Access Condition

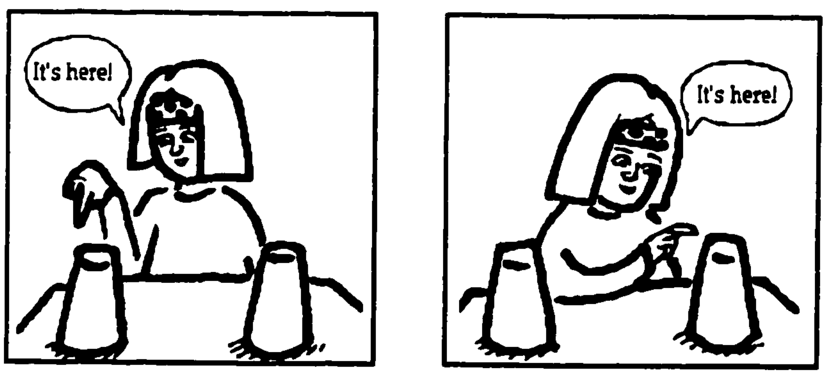
Information Phase

Screen 1 Screen 2



Test Phase

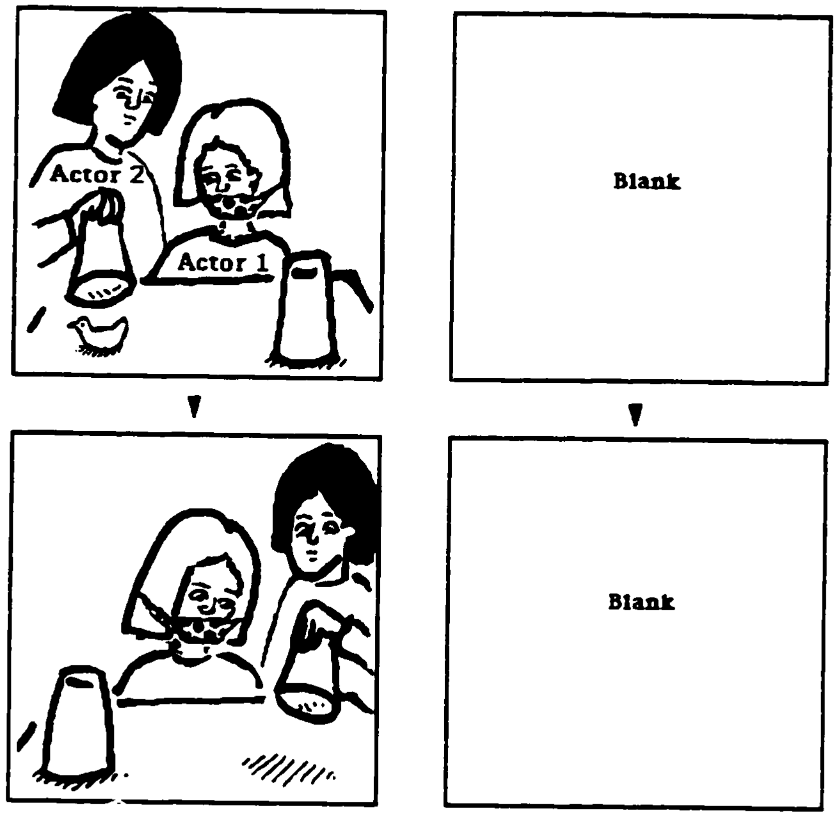
Screen 1 Screen 2



Perception-Knowledge Task: Visual Access Condition

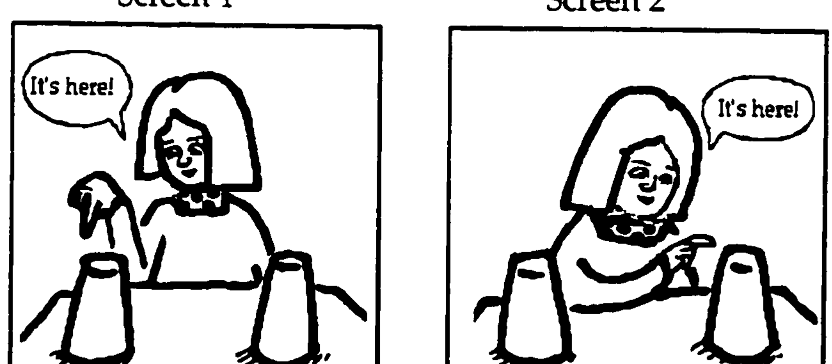
Information Phase

Screen 1 Screen 2



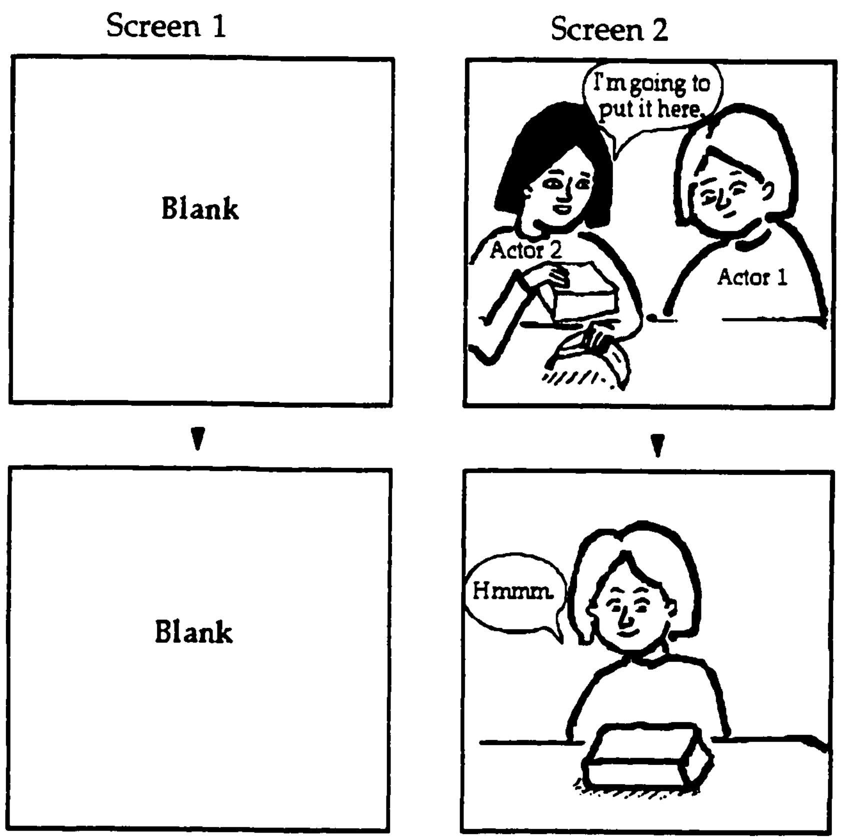
Test Phase

Screen 1 Screen 2

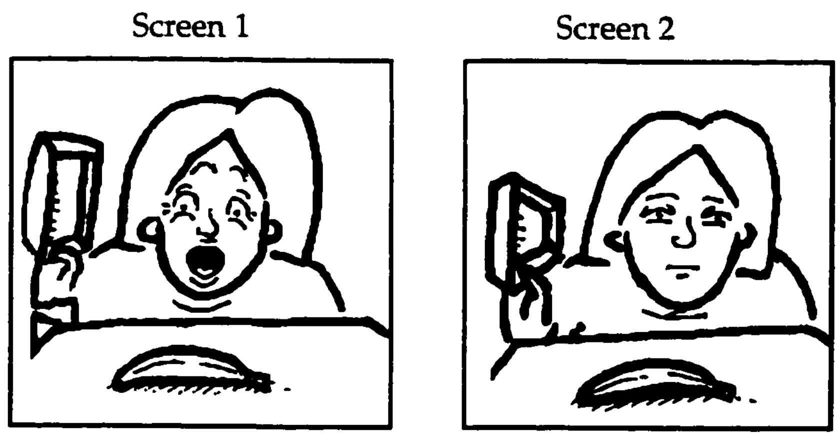


Belief-Emotion Task: Expected Event Condition

Information Phase



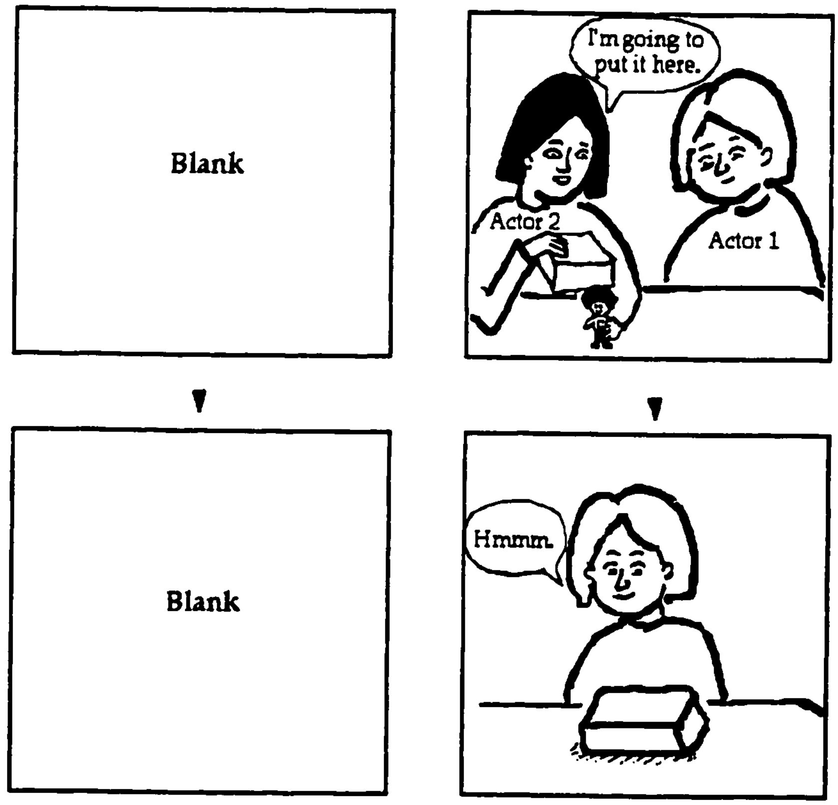
Test Phase



Belief-Emotion Task: Unexpected Event Condition

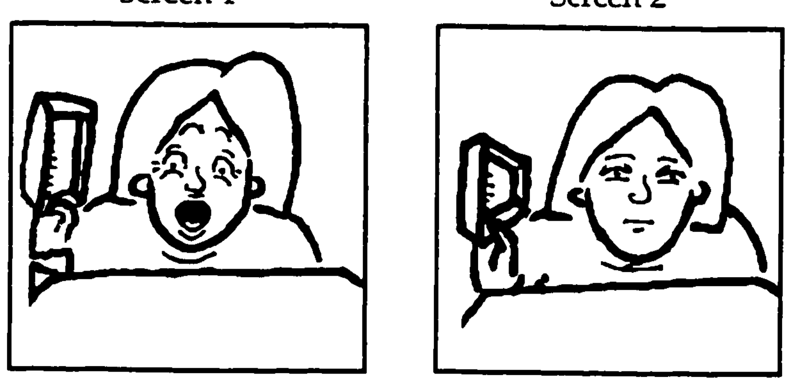
Information Phase

Screen 1 Screen 2



Test Phase

Screen 1 Screen 2



Appendix C

Consent Form, Instructions and Response Form for Adult Emotion Ratings

PICTURE RATING STUDY

Consent Form

In the first part of this experiment you will be asked to look at some videotaped images that were used in a study on infants' understanding of human emotion. The reason we are asking adults to view these images is to ensure that the facial expression displayed by the actor in each image is indeed recognizable as the intended emotion. Some emotions may appear more than once. In the second part, you will be asked to make judgments about pictures of objects. The entire experiment should last about 30 minutes.

I have read the description above and agree to participate in this study.
I understand that I will be paid $5.00 for my participation, and I recognize that I am free to discontinue my participation at any time without negative consequences.

Signature: ____________________ Date: ____________________

Subject #: _____

Age: _____

Gender: M F (circle one)

Instructions and Response Sheet

In this experiment you will be presented with a series of 6 images of actors displaying facial expressions. For each image, you are asked to circle the emotion word that corresponds to the facial expression displayed. In some of the pictures, the actor is shown holding an object. Please disregard the object and focus on the facial expression only. There are no right or wrong answers in this task. Just pick the emotion word that you think matches the face presented. Before starting, please review the 7 possible responses. It is possible that some expressions may occur more than once. **Please circle only one response per image.**

Image # 1
1. angry
2. disgusted
3. fearful
4. happy
5. neutral
6. sad
7. surprised

Image #2
1. angry
2. disgusted
3. fearful
4. happy
5. neutral
6. sad
7. surprised

Image #3
1. angry
2. disgusted
3. fearful
4. happy
5. neutral
6. sad
7. surprised

Image #4
1. angry
2. disgusted
3. fearful
4. happy
5. neutral
6. sad
7. surprised

Image #5
1. angry
2. disgusted
3. fearful
4. happy
5. neutral
6. sad
7. surprised

Image #6

1\. angry

1\. disgusted

3\. fearful

4\. happy

5\. neutral

6\. sad

7\. surprised

Appendix D

Parental Consent Form

Parental Consent Form

Infant's name: ____________________
Birthdate: ____________________
month / day / year

Gender: ___ Language(s) spoken at home ____________________

Mother's name: ______________ Father's name: ______________

Address: ______________ Telephone: ______________ (home)

______________ ______________ (work)

Postal code: ______________

Mother's occupation: ____________ Father's occupation: ____________

Mother's education: ______________ Father's education: ______________

In this study, we are examining children's understanding of people. In particular we want to determine whether infants understand that other people have mental states (e.g. beliefs, desires and emotions) and that human behaviors can be explained in terms of such mental states. In the present task, children will be shown a series of video clips involving actors and objects. The session will be videotaped and all data collected will be kept confidential.

____
Diane Poulin-Dubois, Ph.D.
Associate Professor

____
Joanne Tilden
Ph.D. Candidate

The nature and purpose of this study have been satisfactorily explained to me and I agree to allow my child to participate. I understand that we are free to discontinue participation at any time without negative consequences and that the experimenters will gladly answer any questions that might arise during the course of the research.

____
Parent's signature

____
Date

Subject #: _____ Study: ______________

General Information

The following are some general information questions about your child. All of your responses will be kept confidential.

Birthweight: ________________ Birth order: _____________

Was your baby premature?

Were there any complications during pregnancy?

Has your child has any major medical problems?

Does your child have any hearing or vision problems?

I would be interested in participating in future studies with my child: yes /no

Appendix E

Written Instructions for Parents

Instructions for Parents

1. The task your child will undertake today looks at one very small ability or type of understanding. It is not a test of mental ability, and there are no right or wrong answers.

2. Before beginning the task, please ensure that your child has no toys or food as these items are usually distracting.

3. Once you have been escorted to the video presentation room, please seat your child in the infant seat attached to the table.

4. Next, you should sit down behind your child in the chair provided.

5. Please do not speak to or touch your child for the duration of the experiment (about 6 minutes). Also try not to do anything that would draw your child's attention to you, such as laughing.

6. During the experiment, your child may turn around and look at you a few times. If this occurs, respond with a glance and smile, but try not to engage the child too much.

7. If your child becomes extremely fussy or starts to cry, we will stop the experiment so that you can comfort him or her.

Appendix F

ANOVA Source Tables for Experiment 1

Table F1.

ANOVA Source table for the Perception-Knowledge Task

Source Variation	SS	DF	MS	F	p
		Between-Subject Effects			
Group	3.73	2	1.87	1.69	.191
Error	(97.34)	(88)	(1.11)		
		Within subject Effects			
Knowledge (K)	.19	1	.19	.13	.715
G x K	5.69	2	2.85	2.06	.134
Error	(121.62)	(88)	(2.85)		
Perceptual (P)	3.47	1	3.47	5.77*	.018
G x P	.19	2	.10	.16	.852
Error	(52.89)	(88)	(.60)		
P x K	2.16	1	2.16	1.20	.277
G x P x K	7.51	2	3.76	2.08	.131
Error	(158.81)	(88)	(1.80)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table F2.

ANOVA Source Table for the Belief-Emotion Task

Source of Variation	SS	DF	MS	F	p
			Between-Subject Effects		
Group	8.56	2	4.28	3.13*	.049
Error	(121.82)	(89)	(1.37)		
			Within subject Effects		
Emotion (E)	137.25	1	137.25	93.88**	.000
G x E	24.91	2	12.46	8.52	.000
Error	(130.12)	(89)	(1.46)		
Event	12.18	1	12.18	31.77	.000
G x C	1.09	2	.54	1.42	.247
Error	(34.11)	(89)	(.38)		
E x Event	2.84	1	2.84	1.95	.166
G x E x Event	.13	2	.06	.04	.957
Error	(129.67)	(89)	(1.46)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

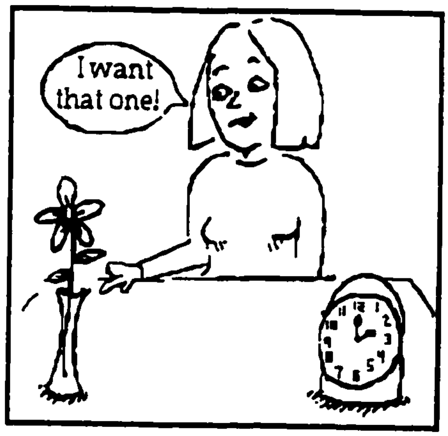
Appendix G

Schematic Representation of Stimuli used in Experiment 2

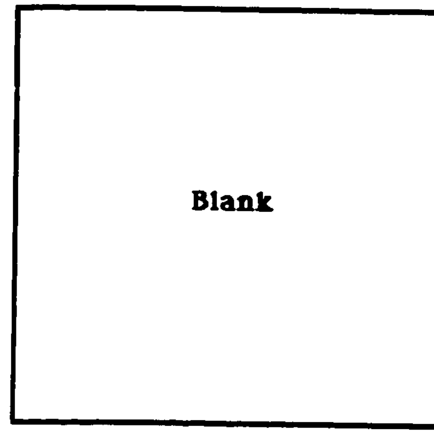
Desire-Action Task

Information Phase

Screen 1

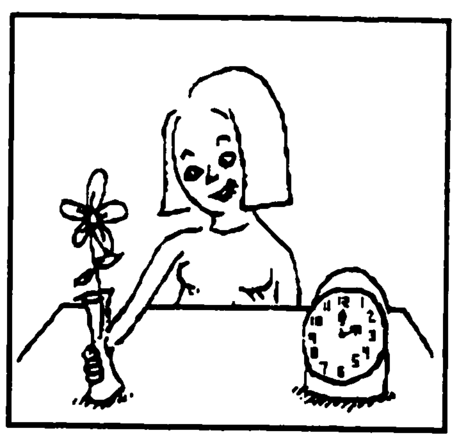


Screen 2

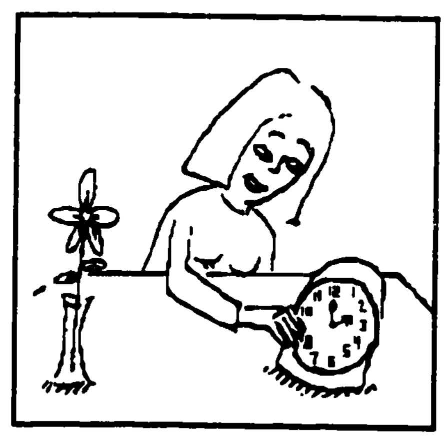


Test Phase

Screen 1



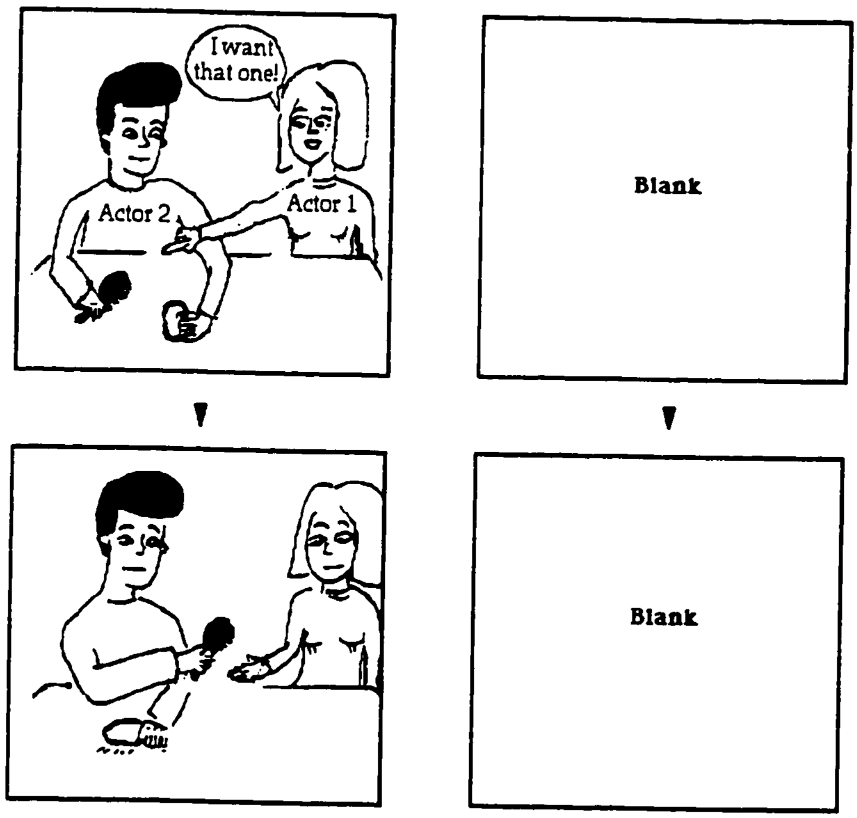
Screen 2



Desire-Emotion Task: Positive Outcome Condition

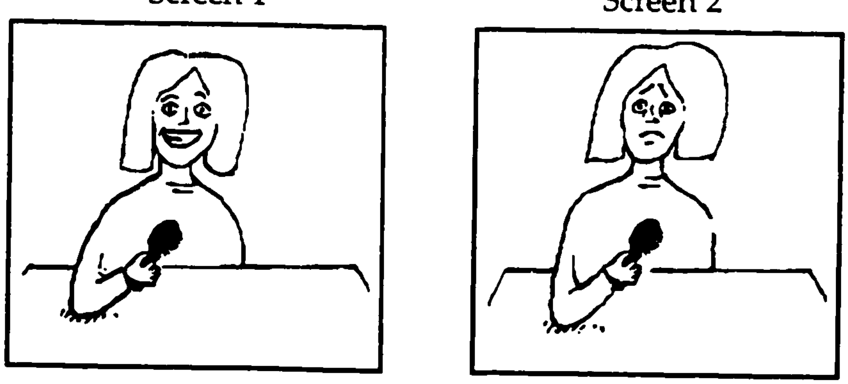
Information Phase

Screen 1 Screen 2



Test Phase

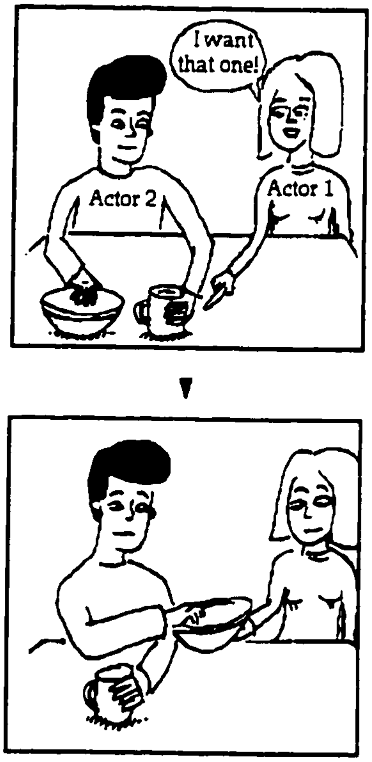
Screen 1 Screen 2



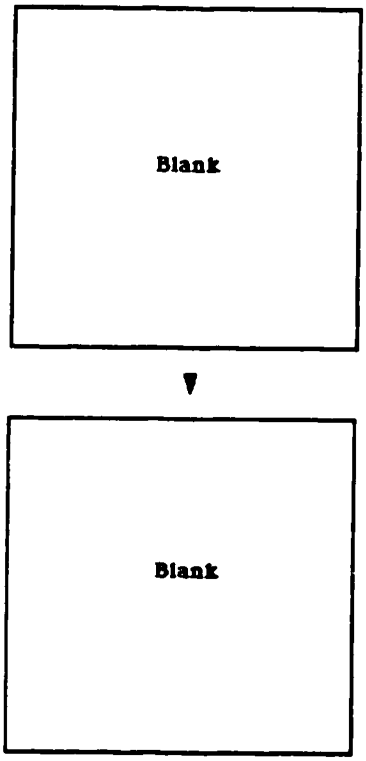
Desire-Emotion Task: Negative Outcome Condition

Information Phase

Screen 1

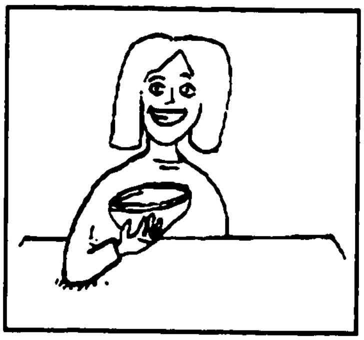


Screen 2



Test Phase

Screen 1



Screen 2

Appendix H

Two Fixed Orders of Trial Presentation in Experiment 2

Order 1

Desire Action Standard Trials

Trial	Object pair
1	flower/clock
2	banana/apple
3	shoe/hat
4	bottle/glasses

Desire Emotion Standard Trials

Trial	Object pair
5	brush/soap
6	fork/spoon
7	red/green
8	cup/bowl

Desire Action Control Trials

Trial	Object pair
9	banana/apple
10	flower/clock

Desire Emotion Control Trials

Trial	Object pair
11	cup/bowl
12	red block/green block

Order 2

Desire Emotion Standard Trials

Trial	Object pair
1	brush/soap
2	fork/spoon
3	red/green
4	cup/bowl

Desire Action Standard Trials

Trial	Object pair
5	flower/clock
6	banana/apple
7	shoe/hat
8	bottle/glasses

Desire Emotion Control Trials

Trial	Object pair
9	cup/bowl
10	red block/green block

Desire Action Control Trials

Trial	Object pair
11	banana/apple
12	flower/clock

Appendix I

ANOVA Source Tables for Experiment 2

Table I1.

ANOVA Source Table for the Desire-Action Task: Standard Trials

Source of Variation	SS	DF	MS	F	p
		Between-Subjects			
Group	3.18	2	1.59	3.95*	.023
Error	(34.22)	(85)	(.40)		
		Within Subjects			
Action	11.39	1	11.39	27.64**	.000
Group x Action	.87	2	.44	1.06	.351
Error	(35.04)	(85)	(.41)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table I2.

ANOVA Source Table for the Desire-Action Task: Analysis of Control Trials

Source of Variation	SS	Df	MS	F	p
		Between-Subjects			
Group	.19	2	.10	.34	.712
Sex	.05	1	.05	.18	.671
Group x Sex	.12	2	.06	.22	.803
Error	(18.70)	(66)	(.28)		
		Within Subjects			
Action	1.23	1	1.23	3.73	.058
Group x Action	.45	2	.22	.68	.512
Sex x Action	2.07	1	2.07	6.30*	.015
Group x Sex x Action	.55	2	.27	.83	.440
Error	(21.74)	(66)	(.33)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table I3.

ANOVA Source Table for the Desire-Emotion Task: Standard Trials

Source of Variation	SS	Df	MS	F	p
			Between-Subjects		
Group (G)	6.42	2	3.21	4.27**	.017
Error	(63.20)	(84)	(.75)		
			Within subjects		
Outcome (O)	.71	1	.71	3.53	.064
G x O	.52	2	.26	1.29	.281
Error	(16.93)	84	(.20)		
Emotion (E)	53.63	1	53.63	52.09**	.000
G x E	1.01	2	.51	.49	.614
Error	(86.47)	(84)	(1.03)		
O x E	.77	1	.77	1.27	.263
G x O x E	.73	2	.37	.60	.549
Error	(51.18)	(84)	(.61)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table I4.

ANOVA Source Table for the Desire-Emotion Task: Analysis of Control Trials

Source of Variation	SS	DF	MS	F	p
			Between-Subjects		
Group	4.90	2	2.45	2.14	.124
Error	(94.92)	(83)	(1.14)		
			Within subjects		
Outcome (O)	.96	1	.96	2.75	.101
G x O	.10	2	.05	.14	.867
Error	(28.93)	(83)	(.35)		
Emotion (E)	78.80	1	78.80	82.85**	.000
G x E	.27	2	.14	.14	.867
Error	(78.95)	(83)	(.95)		
O x E	.78	1	.78	1.23	.271
G x O x E	.29	2	.14	.22	.799
Error	(52.94)	(83)	(.64)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

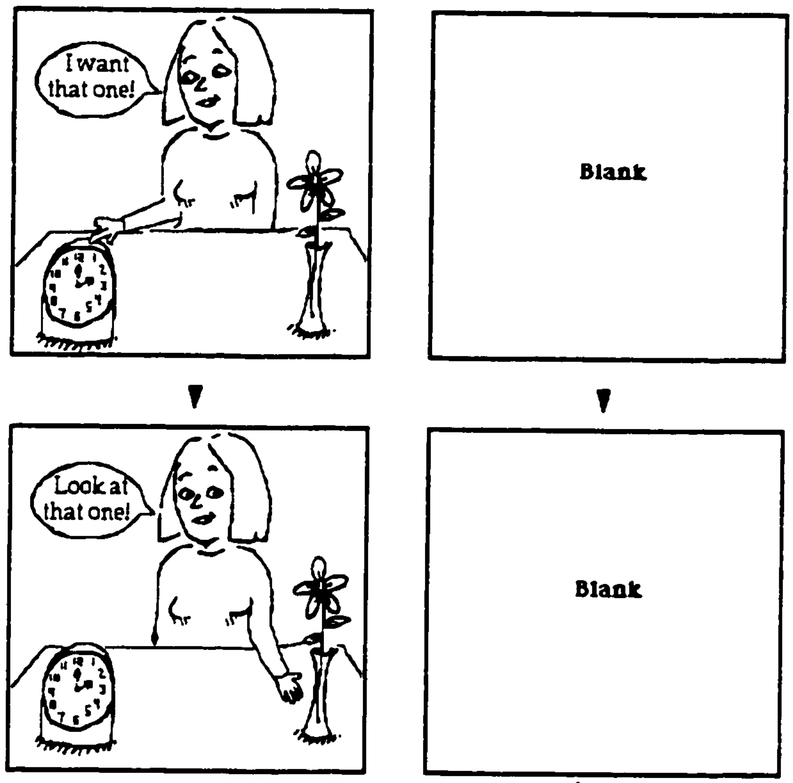
Appendix J

Schematic Representation of Stimuli used in Experiment 3

Desire-Action Follow-up Task

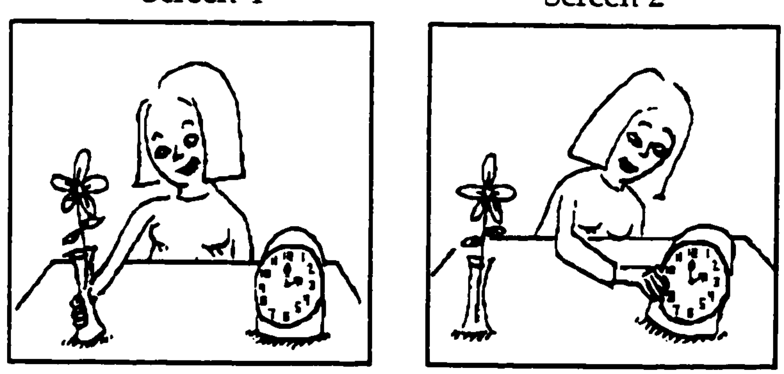
Information Phase

Screen 1 Screen 2



Test Phase

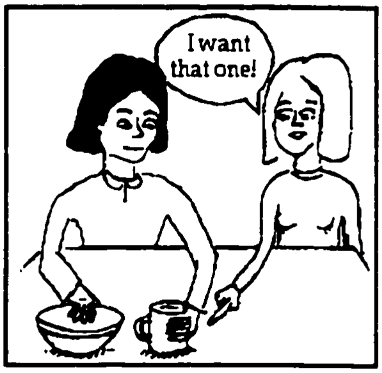
Screen 1 Screen 2

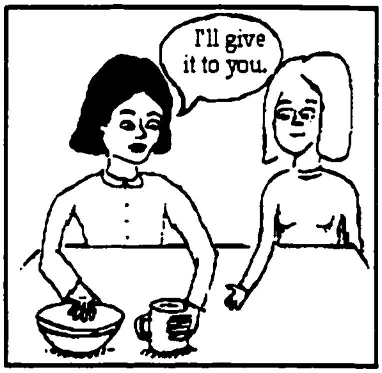


Desire-Emotion Follow-up Task: Happy Condition

Information Phase

Screen 1





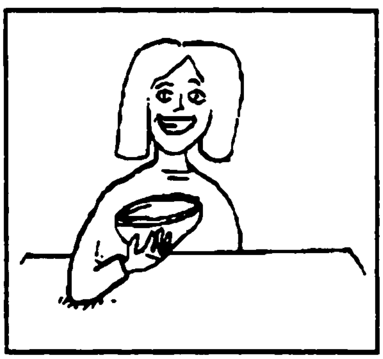
Screen 2

Blank

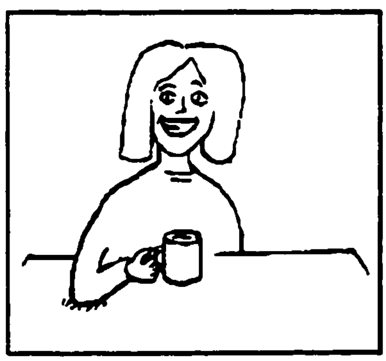
Blank

Test Phase

Screen 1



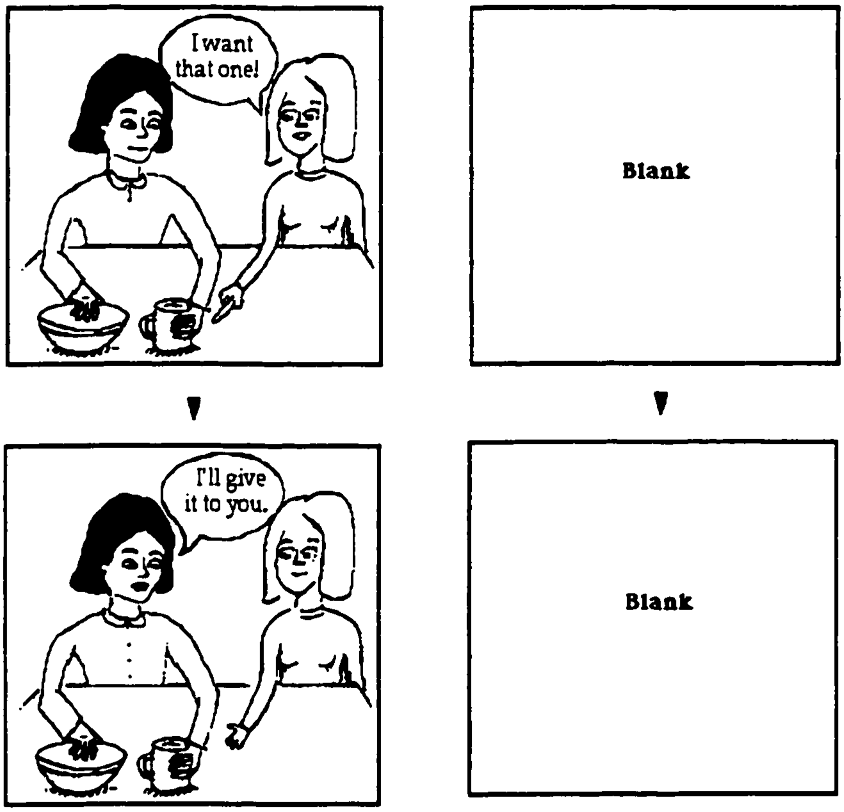
Screen 2



Desire-Emotion Follow-up task: Sad Condition

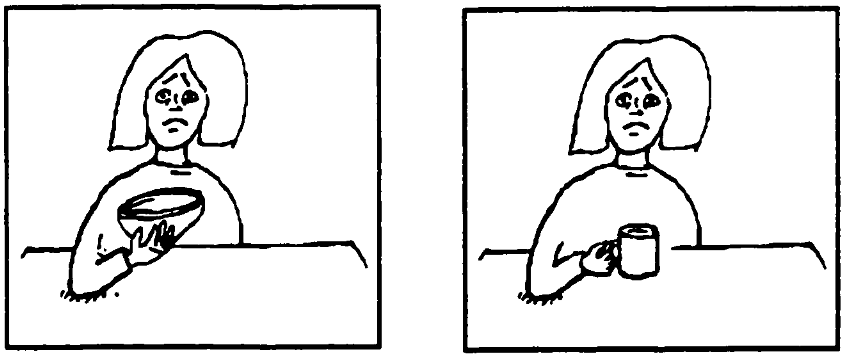
Information Phase

Screen 1 Screen 2



Test Phase

Screen 1 Screen 2



Appendix K

Source Tables for Experiment 3

Table K1.

ANOVA Source table for the Revised Desire-Action Task: Standard Trials

Source of Variation	SS	DF	MS	F	p
			Between-Subjects		
Gender (G)	.08	1	.08	.12	.735
Error	(18.72)	(26)	(.72)		
			Within Subjects		
Action (A)	.58	1	.58	1.08	.308
G x A	.28	1	.28	.53	.473
Error	(13.90)	(26)	(.53)		
Order (O)	.33	1	.33	1.58	.220
G x O	.80	1	.80	3.86	.060
Error	(5.35)	(26)	(.21)		
A x O	.56	1	.56	.68	.417
G x A x O	2.44	1	2.44	2.96	.097
Error	(21.48)	(26)	(.83)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table K2.

ANOVA Source table for the Revised Desire-Action Task: Analysis of Control Trials

Source of Variation	SS	DF	MS	F	p
		Between-Subjects			
Gender (G)	.84	1	.84	2.60	.119
Error	(8.11)	(25)	(.32)		
		Within Subjects			
Action (A)	.15	1	.15	.19	.671
G x A	.00	1	.00	.00	.983
Error	(20.04)	(25)	(.80)		
Order (O)	.20	1	.20	1.15	.295
G x O	.05	1	.05	.27	.610
Error	(4.41)	(25)	(.18)		
A x O	.08	1	.08	.11	.746
G x A x O	.74	1	.74	1.00	.327
Error	(18.44)	(25)	(.74)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table K3.

ANOVA Source table for the Revised Desire-Emotion Task: Standard Trials

Source of Variation	SS	DF	MS	F	p
			Between-Subjects		
Gender (G)	.11	1	.11	.89	.353
Error	(3.38)	(28)	(.12)		
			Within Subjects		
Emotion (E)	.18	1	.18	2.89	.100
G x E	.00	1	.00	.07	.798
Error	(1.71)	(28)	(.06)		
Outcome (O)	1.59	1	1.59	1.51	.230
G x O	.27	1	.27	.26	.616
Error	(29.49)	(28)	(1.05)		
E x O	16.21	1	16.21	15.61**	.000
G x E x O	.00	1	.00	.00	.958
Error	(29.07)	(28)	(1.04)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.

Table K4.

ANOVA Source Table for the Revised Desire-Emotion Task: Analysis of Control Trials

Source of Variation	SS	DF	MS	F	p
			Between-Subjects		
Gender (G)	.04	1	.04	.18	.673
Error	(6.53)	(28)	(.23)		
			Within Subjects		
Emotion (E)	.16	1	.16	.99	.327
G x E	.31	1	.31	1.85	.185
Error	(4.63)	(28)	(.17)		
Outcome (O)	.91	1	.91	1.01	.324
G x O	.31	1	.31	.34	.564
Error	(25.19)	(28)	(.90)		
E x O	.46	1	.46	.52	.475
G x E x O	.04	1	.04	.04	.837
Error	(24.64)	(28)	(.88)		

Note. Values enclosed in parentheses represent mean square errors. * $p < .05$, ** $p < .01$.