Understanding Intention and Desire in the Second Year: Developmental Changes and Relations among These Abilities

Kara M. Olineck

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ABSTRACT

Understanding intention and desire in the second year: the developmental changes and relations among these abilities

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The present experiments investigated the developmental change in infants' concept of intention, and the link between intention and desire understanding in the second year. In Experiment 1, we compared 14- and 18-month-old infants' ability to differentiate between intentional and accidental actions. In Experiment 2, we compared 18-month-olds' ability to infer subjective desires for objects and their performance on the previous task. Also, performance on these theory of mind tasks was correlated with mental lexicon six months later. A developmental progression in infants' understanding of intention was observed. Surprisingly, 18-month-old infants were unable to infer subjective desires for objects. No relationship was found between infants' understanding of intention, desire, and their mental lexicon. These results have methodological and theoretical implications for research exploring theory of mind in infancy.

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Theory of mind refers to the understanding that people have mental states (i.e., intentions, desires, and beliefs) that influence their behavior. By the time children reach 4 or 5 years of age, they have a representation of the mind, and are capable of understanding other people's behavior in terms of their beliefs and desires (Wellman, Cross, & Watson, 2001).

Although a full-fledged understanding of the mind does not emerge until 4 or 5 years of age, a substantial amount of research has indicated that even 2- and 3-year-olds understand other people's intentions and desires (Bartsch &Wellman, 1995). Three-year-olds recognize that people act intentionally in order to achieve an outcome, and they can distinguish intentional actions from other non-purposeful actions such as accidents or movements due to reflexes or gravity (Call & Tomasello, 1998; Schult & Wellman, 1997; Shultz, 1990). By the time children reach 2 ½ years of age, they understand the link between other people's desires, perceptions, and emotions (Wellman, Phillips, and Rodriguez, 2001). Two-year-olds are also able to accurately predict other people's actions based on their expressed desire. For example, Wellman and Woolley (1990) presented stories to 2 ½-year-old children in which a character desired a specific object. The investigators asked the children to make predictions about the character's behavior and emotional reactions in situations where he either did or did not find the object he wanted. The results suggested that 2 ½ year-old children understand that people engage in specific behaviors designed to satisfy their desires. Their results also indicated that children this age are able to accurately predict whether someone will feel happy or sad, depending on whether or not their expressed desire was fulfilled (c.f., Rieffe, Terwogt, Koops, Stegge, & Oomen, 2001). Thus, a number of investigations have indicated that

by the end of the second year of life, children understand that people have intentions and desires that influence their emotions and subsequent actions.

An important issue to consider is the foundation of intention and desire understanding in infancy. By their first birthday, infants are sensitive to goal-directed action and can detect the goals of other people using cues such as eye gaze and emotion (Baird & Baldwin, 2001; Gergely, Nadasdy, Csibra, & Biro, 1995; Phillips & Wellman, & Spelke, 2002; Woodward, 1998). However, infants' sensitivity to intentional action at 12 months of age does not necessarily constitute evidence for an early understanding of the mental state of intention. Instead, it has been suggested that this sensitivity to goal-directed action may be a precursor to the development of a more advanced understanding of intention that emerges during the second year of life (Baird & Baldwin, 2001).

In his landmark study on early intention understanding, Meltzoff (1995) showed 18-month-old infants an actor who tried, but failed to complete an action (e.g., actor was shown attempting to pull apart the ends of an object shaped like a dumbbell) and then gave them the opportunity to manipulate the object. He found that infants reproduced what the actor was trying to do (i.e., pull apart the object), even though they had never seen this action successfully completed. Moreover, infants who saw these "failed attempts" were as likely to produce the target action as infants who had seen a demonstration in which the actor achieved his goal. The infants who were shown an actor attempting, but failing, to complete the target action were also significantly more likely to reenact the target action than infants in control groups who either saw no demonstration, or simply watched the actor handling the objects. These results provide evidence that, by 18 months of age, infants can infer the intentions of others. In another

experiment designed to test whether 18-month-olds attribute mental properties distinctly to people, Meltzoff (1995) replicated the previously described study using a mechanical device as opposed to an actor. He found that, contrary to the first experiment, infants tended not to produce the unseen, intended action of a mechanical device. It appears that 18-month-olds understand that people's actions are driven by underlying goals and intentions, and that these mental attributions can not be extended to inanimate objects.

Meltzoff's (1995) investigation prompted a number of researchers to conduct follow-up experiments. One pertinent question to be addressed was whether infants possessed similar levels of understanding about intentions at earlier ages. Bellagamba and Tomasello (1999) used the behavioural re-enactment technique in order to replicate Meltzoff' s (1995) findings with 18-month-olds and to examine whether 12-month-old infants would also make inferences about the intentions underlying another person's unsuccessful attempts to fulfill a goal. They found that, although the 18-month-olds understood what the actor was attempting to do and thus reproduced behaviour with the same intention, 12-month-old infants did not. Their results provide evidence to suggest that, at the end of the first year of life, infants need to observe the outcome of a goal-directed action before they are able to infer the intentions underlying that person's actions. In another follow-up study, Johnson, Booth, and O'Hearn (2001) examined whether infants would attribute goals to a nonhuman actor that possessed human characteristics (i.e., face, self-propulsion, and contingency) that might signal the presence of a mind. The investigators used the behavioral reenactment procedure and tested whether 15-month-old infants would read below the surface behaviors (i.e., failed attempts) demonstrated by an orangutan puppet. Their results indicated that infants as

young as 15 months of age interpreted the behaviors of the nonhuman agent as intentional, and reproduced behaviors with the same goals in mind. Their research suggests that, although younger infants recognize goals underlying behavior, they may over-generalize their attributions of intention to nonhuman agents who possess characteristics such as a face, self-propulsion, and the ability to interact contingently.

Another way to explore infants' understanding of intention is to test whether, like preschoolers, they are able to differentiate between actions completed purposefully and those done by mistake. Carpenter, Akhtar, and Tomasello (1998) conducted an investigation in order to examine whether infants could discriminate between intentional and accidental actions modeled by an adult, and whether they would prefer to reproduce the intentional actions. They tested infants ranging in age from 14 to 18 months of age, with the average participant being 16-months-old. The infants were shown objects that had two attachments that could be manipulated (e.g., a bird feeder with a movable top and an attached ring that could be pulled) to produce an end result (e.g., inflatable party favour). The demonstrations included both accidental actions (i.e., actor said "Whoops!" while completing the action) and intentional actions (i.e., actor said "There!" while completing the action) that were designed to look as natural as possible. During some trials infants saw an intentional action followed by an accidental action, on some trials infants were shown an accidental action and then an intentional action, and some demonstrations included two intentional actions. After the intentional action was modeled by the experimenter, a second experimenter surreptitiously activated the end result attached to the object, so that it appeared as though performing that action had "caused" the end result to occur. Following the demonstration, infants were given a turn

(i.e., "Can you make it work?") and were shown the end result shortly after they reproduced the intentional action.

Overall, infants reproduced significantly more intentional than accidental actions, and completed the intentional action by itself more often than they produced any other type of response (i.e., both actions, accidental action only). Moreover, the infants' tendency to reproduce the intentional actions did not increase across trials, ruling out the possibility that they preferentially reproduced this action type simply because they had learned the association between completing the intentional action and viewing the amusing end result. In order to examine whether there is a developmental trend within the 14 to 18 month age range, the researchers correlated the infants' age in days at the time of testing with the percentage of intentional and accidental actions completed overall. There was no significant relationship between infants' age and their ability to differentiate intentional and accidental actions. Therefore, Carpenter and her colleagues (1998) concluded that infants from 14 through to 18 months of age have some understanding of the intentions of other people. A methodological limitation of Carpenter, Akhtar, and Tomasello (1998) is that there were not enough infants at either end of their age range to clearly investigate the presence of a developmental trend in infants' understanding of intention. Therefore, one goal of the present study was to examine the development of intention understanding by testing separate groups of 14- and 18-month-old infants in order to enhance the possibility of detecting a developmental pattern in the infants' ability to differentiate between accidental and intentional action.

Apart from studies on intention, research has also begun to explore preverbal infants' desire reasoning abilities. Recently, there have been a few studies which have

suggested that by 18 months of age, infants have some understanding of the mental state of desire (e.g., Flavell, 1999; Meltzoff, Gopnik, & Repacholi, 1999). For instance, Tilden, Poulin-Dubois, and Desroches (as cited in Poulin-Dubois, 1999) tested 18- and 24-month-old infants in order to explore the hypothesis that infants as young as 18 months of age would understand the link between the outcome of a person's expressed desire (i.e., she gets what she wants or she does not) and subsequent emotional expressions (i.e., happy or sad facial expressions). A preferential looking paradigm was used, in which infants faced two screens that depicted videotaped scenarios. In the information phase, participants saw two female actors seated at a table with two objects placed in front of Actor 1. This actor expressed her desire for one of the objects (i.e., "I want that one!" while looking and pointing), and actor 2 said "I will give it to you", while placing her hand above and between the two objects. This information phase, which lasted approximately 20 seconds, was followed by a brief pause during which both screens were black. Then, infants were presented with two still frame images depicting the positive outcome (i.e., Actor holding desired object) and the negative outcome (i.e., Actor holding undesired toy). Actor 1, who expressed her desire and received the objects, displayed a happy face for both outcomes during two trials and a sad face for both outcomes during the other two trials. If infants understand the link between desire fulfillment and positive emotion, they should look differentially at the incongruent screens (e.g., actor looks sad while holding the object she desired) and at the congruent screens (e.g., actor looks happy while holding her desired object). The results confirmed this hypothesis, with infants looking longer at the congruent screens than the incongruent screen across all trials. Therefore, this experiment suggests that infants as young as 18 months of age understand

that people have an internal experience of wanting, which leads them to looking happy when they get what they desire and sad when they do not.

Infants' understanding of desire has also been examined using interactive procedures (e.g., Repacholi & Gopnik, 1997; McKoy and Poulin-Dubois, 1999). In their innovative study, Repacholi and Gopnik (1997) presented 14- and 18-month-old infants with two types of food, one that was expected to be desirable (i.e., crackers) and one that was expected to be undesirable (i.e., broccoli). Following a baseline trial in which infants' preference for the crackers was confirmed, the experimenter tasted each of the foods and demonstrated pleasure (i.e., smiled and said "Mmm!") after tasting one food and disgust (i.e., grimaced, and said "Eww!") after tasting the other. The food that was preferred by the experimenter depended on the experimental condition. In the match condition, the experimenter expressed pleasure while tasting the crackers and disgust while tasting the broccoli, thereby matching the infants' presumed preferences. In the mismatch condition, the experimenter's preferences were reversed, making this condition a more stringent test of infants understanding of the subjectivity of this mental state. After the experimenter indicated her preferences, she made a request for food (i.e., "Can you give me some?").

The investigators found that 18-month-old infants were able to infer the desires of other people, both when the expressed desire was consistent (76%) and inconsistent (69%) with their own preferences. The 14-month-old infants had difficulty complying with the task (i.e., 68% of participants failed to respond to the request). Of the 14-month-olds that responded to the experimenter's request, only 54% of them offered the experimenter her desired food. The majority of the 14-month-olds tended to respond to

the experimenter's request in terms of their own preferences by giving her crackers regardless of the preferences she displayed. Based on these findings, Repacholi and Gopnik (1997) concluded that 18-month-old infants are able to understand subjective desires, as well as the link between emotion and desire outcome. Given the 14-month-old infants' performance on the task, the researchers postulated that there may be a developmental transition in infants' conceptual understanding of the internal state of desire during the second year of life. However, it has been noted by the investigators that there is a possibility that infant's understanding of desire is unique to food. From an evolutionary perspective, it is important for infants' to recognize food preferences at an early age. Thus, a pertinent question to be addressed is whether this early understanding of desire can be extended beyond food.

In order to examine this question, McKoy and Poulin-Dubois (1999) adapted Repacholi and Gopnik's (1997) food request task by presenting 18-month-old infants with blue and green toy blocks. Due to the similarity of the blocks, there was no match or mismatch condition, thus infants' responses can not be attributed to their own initial preferences. The experimenter expressed desire for one of the blocks (i.e., picked up block, smiled, and said "Wow!") and disgust for the other (i.e., push the block away, grimaced, and said "Eww!"). Following this demonstration, participants were asked to give the experimenter a block. It was found that the 18-month-old infants did not reliably give the experimenter the block she desired. These results conflict with Repacholi and Gopnik's (1997) findings, and suggest that 18-month-old infants' ability to infer the subjective desires of others may not extend to objects.

However, it is possible that 18-month-old infants did not understand the actor's desire for objects in McKoy and Poulin-Dubois's (1999) study because of the objects chosen. Infants might not have been convinced that an individual could be disgusted by a particular toy block. Moreover, it is possible that expressing disgust towards objects in general is not as plausible as expressing disgust towards food. Before concluding that 18-month-old infants' ability to infer desire can not be extended to objects, research is needed in order to replicate the food request task using an object assumed to be desirable to the child (i.e., as desirable as a cracker) and an object assumed to be unattractive to the child (i.e., as undesirable as broccoli). Additionally, rather than expressing disgust toward the undesired object, a negative emotion that is more plausibly directed at objects should be expressed (i.e., dislike, avoidance). One of the goals of the present study was to examine whether 18-month-old infants can infer subjective desires for objects, when the objects are either consistent or inconsistent with their own preferences.

Intention and desire understanding have also been documented in children's early lexicon (e.g., Bartsch and Wellman, 1995; Bretherton & Beeghly, 1982). In a ground-breaking study, Bartsch and Wellman (1995) analysed thousands of child conversations about the mind, concentrating on the use of terms about desires and beliefs. Their data came from 10 children that were followed longitudinally from 1 ½ to 6 years of age. The researchers found that children's conversations about the mind begin early with talk about desires and intentions (i.e., want, wish, hope, care, afraid). Children's first desire term is predominantly the word "want", and by 28 months of age, the majority of children routinely use this term in reference to an internal mental state (e.g., "I don't want

to go to sleep"). Thus, by their second birthday, children demonstrate an understanding of subjective desires and related intentions through their everyday conversations.

Studies investigating early understanding of intention and desire have also collected information about infants' vocabulary at the time of testing. For example, Carpenter and colleagues (1998) examined whether there was a relationship between infants' general productive vocabulary, as measured by the short form of the MacArthur Communicative Development Inventory, and their ability to discriminate between accidental and intentional actions. No significant relationship was found between infants' vocabulary and their performance on the intention task. A methodological limitation of this study was that the average age of the infants tested was 16 months; therefore, infants' limited lexicon may have contributed to this null effect. Repacholi and Gopnik (1997) also explored the link between infants' understanding of desire and productive vocabulary, by collecting information regarding the infants' use of internal state words (i.e., words reflecting emotions, perceptual states, physiological states, etc.) at the time of testing. No significant relationship was found between infants' use of internal-state terms and their performance on the desire task. However, the majority of participants (86.5% of 14-month-olds and 79.5% of 18-month-olds) were not even producing internal-state terms at the time of testing. As in the previous study, infants' limited lexicon likely contributed to this null effect. Therefore, a goal of the present study was to examine the relationship between 18-month-old infants' performance on the intention and desire tasks and their productive vocabulary at time of testing and shortly after their second birthday. As well, information about infants' use of mental terms at 24 months of age will be collected in order to explore whether there is a predictive

relationship between their understanding of the mind at 18 months of age, and their talk about the mind 6 months later.

The present experiments were conducted with four objectives in mind. First, 14- and 18-month-old infants' understanding of intention was explored in order to clarify whether there is a developmental progression in infants' ability to differentiate between accidental and intentional actions early in the second year of life. Given the results reported by Carpenter and colleagues (1998), it was hypothesized that infants at both ends of this age range would demonstrate some understanding of intentionality. Second, 18-month-old infants' understanding of subjective desires was tested in order to elucidate whether their documented ability to reason about the desires of others can be extended beyond food (e.g., Repacholi & Gopnik, 1997). Third, the relationship between infants' understanding of intention and desire was examined. Given that independent research projects have found that 18-month-old infants understand intention and desire (e.g., Meltzoff, 1995; Carpenter et. al., 1998; Repacholi & Gopnik, 1997), it is expected that there will be relationship between the participants performance on these two theory of mind tasks. Finally, data on the participants' productive vocabulary and mental lexicon at 24 months was collected in order to examine whether there is a predictive relationship between infants' understanding of intention and desire early in the second year of life, their productive vocabulary, and their mental lexicon shortly after their second birthday.

Experiment 1

There is evidence to suggest that 18-month-old infants' have some understanding of intention (e.g., Carpenter et. al., 1998). However, there are inconsistent findings regarding the sophistication of younger infants' concept of intention (e.g. Carpenter et.

al., 1998; Johnson et. al., 2001). Therefore, the goal of this experiment was to compare 14- and 18-month-old infants' ability to discriminate between intentional and accidental actions, as well as their tendency to preferentially reproduce the intentional actions.

Method

Participants. Thirty 18-month-old infants (21 females, 9 males; *M*=18.43 months, *SD*= 0.35; range =17.85 to 19.33 months) and 26 14-month-old infants (12 females, 14 males; *M*=14.59 months, *SD*= 0.58; range =13.46 to 15.36 months) were included in the final sample. Twelve of the infants were tested in French, and the remaining 18 infants were tested in English. Four additional infants were tested but were excluded from the final sample due to excessive fussiness (*n*=1) and experimenter error (*n*=3). Additionally, 7 infants were tested in a pilot study in order to examine the suitability of the stimuli and experimental apparatus. The infants were recruited from birth lists provided by a public health services office.

Materials. The stimuli used in this experiment were toy devices that activated attractive computer animation displays. They were modeled after the objects used in the study by Carpenter et al. (1998). A rectangular wooden box (38 cm long, 25 cm wide, 9 cm tall) with six removable lids was constructed for the experiment. Embedded in the center of each of the box lids were toy devices that could be easily manipulated by the infant (e.g., handle that twists). Two of the box lids were always used in the warm-up phase of testing and the remaining four lids were randomly assigned to four experimental trials. One of the lids used in the warm-up phase of testing included one toy device and the remaining five box lids included two toy devices that were matched for size and level

of attractiveness. Pictures of the box lids used in the experimental trials are presented in Figure 1.

The base of the box was visibly connected to a computer monitor via a telephone cord. The manipulation of the toy devices appeared to activate a computer animation displayed on the monitor for approximately eight seconds. The animations were surreptitiously activated by the experimenter who pressed a key on the keyboard positioned under the table. Six computer animations, created using Director 6.0 for Macintosh and exported into QuickTime ™ movies [computer software], were randomly assigned to each trial. The animations included sound and consisted of either a familiar animal pushing an object across the screen or an artificial creature jumping over an obstacle.

Procedure. The procedure for this experiment was modeled after the procedure used by Carpenter and colleagues (1998). Prior to the testing session, infants were given the opportunity to become familiar with the investigator and their surroundings. The investigator explained the experimental rationale and procedure to the parent and obtained informed consent. Parents were also asked to provide demographic information (i.e., gestation period, medical problems) and to fill out the short form of either the MacArthur Communicative Development Inventory (Fenson, Pethick, Renda, Cox, Dale, & Reznick, 2000) or a French version adapted by the investigators for the present study. Parents were instructed to keep their interactions with their infant to a minimum during the testing session (i.e., only if their infant becomes excessively fussy) and to avoid

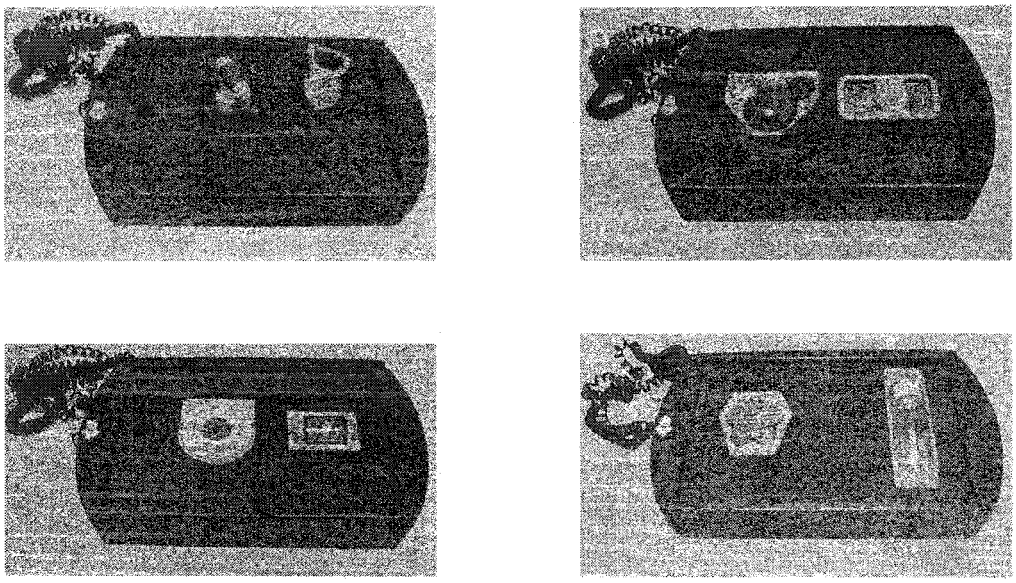

Figure 1. Box lids used in experimental trials to demonstrate intentional and accidental actions.

pointing to the toy devices or encouraging their infant to respond. When it was time for the session to begin, infants were brought into the testing room and seated across a table from the investigator either in a booster chair or on their parent's lap.

The warm-up phase of the experiment consisted of two trials designed to familiarize infants with link between the manipulation of the toy devices and the activation of the computer animation displays. In both the warm-up and test phases, infants were prohibited from exploring the box prior to the investigator's demonstration. The first warm-up trial always involved a box lid with one toy device attachment (i.e., a handle that turns). The investigator announced "Watch me! I'm going to show you how this works" and proceeded to model the action very deliberately with no vocalizations and a neutral facial expression. After the action was completed, a randomly selected computer animation was displayed on the computer monitor. The experimenter gestured toward the computer and showed excitement about the computer display. Then she said "Now your turn! Can you make it work?" If the infants reproduced the model action, the computer animation was activated. If not, the action sequence and resulting animation was demonstrated again. Infants who did not reproduce the modeled action after this second demonstration were coached by the investigator until they successfully activated the computer animation display. The same procedure was followed in the second trial of the warm-up phase; however, the second box lid consisted of two toy device attachments. A sequence of two actions was modeled (i.e., a handle was twisted and a button was pushed) and then a computer animation was displayed. In order to activate the computer animation, infants were required to reproduce both actions in the order they were modeled. This warm-up trial ensured that the infants were capable of correctly

reproducing an action sequence. The investigator did not proceed to the test phase of the experiment until the infants had reproduced the sequence of modeled actions.

During the test phase, the same procedure was employed. However, the stimuli used in the four experimental trials were box lids with two toy device attachments and the investigator's demonstration always consisted of a sequence of two actions. One of the actions was portrayed as accidental and the other as intentional. The accidental action consisted of the investigator looking away from the box lid, while completing the action, and then putting a hand to her mouth and saying "Whoops!" with suitable intonation. Additionally, during the "accident" the investigator's face registered surprise and her upper body jumped up slightly. An intentional action consisted of the investigator looking attentively at one of the specific devices, completing the action slowly, and then smiling and saying "There" with appropriate intonation. During the completion of the intentional action, the investigator also leaned slightly toward the devices. The action sequence demonstrated by the investigator always resulted in activating a computer animation display. Infants received one demonstration per trial, unless they were inattentive during the investigator's demonstration. Infants were then given the opportunity to activate the animation (i.e., "Now your turn. Can you make it work?"). If infants did not respond immediately the investigator repeated the prompt (i.e., "Can you make it work?") and encouraged infants to explore the box until they responded in some way or became fussy. The computer animation was activated approximately two seconds after infants reproduced the intentional action. This delay provided infants with the opportunity to also reproduce the accidental action. The computer animation was not activated in cases where infants only reproduced the accidental action. If infants failed to

activate the end result, the investigator proceeded to the next experimental trial (i.e., "Okay. Let's try another one!"). After all four of the experimental trials were completed, the infant and parent were taken back to the reception area. Infants were given a certificate of merit for their participation and parents were sent a letter explaining the results of the study after data collection was completed.

Design. During the test-phase of the experiment, the investigator's demonstrations of intentional and accidental actions were counterbalanced so that the order of the action sequence (i.e., accidental-intentional or intentional-accidental) alternated across the four trials. Also, the device used to model the intentional action was counterbalanced such that half the time the device on the left-hand side was used and half the time the device on the right-hand side was used. Furthermore, the order in which the four experimental box lids were presented was counterbalanced so that each box lid was assigned to the four test trials at an equal rate.

Coding and Reliability .Each participant was videotaped and all tapes were coded by the primary investigator. The coding scheme for this experiment was modeled after the one used by Carpenter et al. (1998). Infants were coded as having manipulated a device (i.e., reproduced an action) if their attention was directed at the device and they were obviously attempting a manipulation. In the warm-up trials, infants were coded as having reproduced the action on their first attempt, after coaching from the experimenter, or not at all. All infants successfully reproduced the actions demonstrated in both warm-up trials. In the test phase, infants' actions on each device, and the order in which the actions occurred, were coded. If infants repeatedly manipulated one device (e.g., pushed button several times) it was coded as the same action. In the cases where infants

manipulated both devices at the same time they were coded as completing the actions simultaneously. Infants who touched one device while actively manipulating the other device were coded as reproducing the action associated with the device occupying their attention.

In order to establish inter-rater reliability, 20% of the data (n=12) was coded by a second coder. In the sample of 18-month-old infant's, there was 99% agreement between coders, and in the 14-month-old sample the agreement between the two coders was 95%.

Results

In order to examine whether there were differences between 14- and 18-month-old infants' ability to differentially reproduce intentional and accidental actions, we compared the percentage of intentional and accidental actions reproduced by the infants. To calculate the percentage of intentional actions reproduced, we divided the number of intentional actions reproduced (maximum score=4) by the total number of times the action was modeled and multiplied this number by 100. The percentages of accidental actions reproduced were calculated the same way. These data were submitted to a 2 (Age group: 14-month vs. 18-month) by 2 (Action type: intentional vs. accidental) mixed model repeated measures analysis of variance (ANOVA). Action was a within-subjects factor and age group was a between-subjects factor.

Overall, there were no differences between the percentage of actions completed by 14- and 18-month-old infants (M=86.06% and M=84.58%, respectively), $F(1, 54)$= 0.16, $p > .05$. The absence of an age effect indicated that both groups of infants were highly successful at imitating the actions using the toy devices. However, there was a significant effect of action, $F(1, 54)$= 37.63, $p < .01$. Overall, infants reproduced more

intentional actions (95.26%) than accidental actions (75.39%). Furthermore, the analysis revealed a significant interaction between action and age group, $F(1, 54)=8.23$, $p<.01$. Pairwise comparisons with a Bonferroni correction were used to examine the source of the interaction. Both the 14- and 18-month-old infants produced significantly more intentional than accidental actions ($F(1, 54)=4.98$, $p<.05$ and $F(1, 54)=43.65$, $p<.05$, respectively). The analyses revealed that 18-month-old infants reproduced significantly more intentional actions ($M=99.17\%$) than 14-month-old infants ($M=91.35\%$), $F(1, 54)=4.96$, $p<.05$. However, there were no differences in the percentage of accidental actions reproduced by the 18- ($M= 70.00\%$) and 14-month-old ($M=80.76\%$) infants, $F(1,54)= 3.22$, $p>.05$. Figure 2 illustrates the mean percentages of each type of action that were reproduced by both age groups of infants.

In the second set of analyses, we examined infants' ability to discriminate between intentional and accidental actions by comparing the average difference score (i.e., the difference between the percentages of intentional and accidental actions reproduced) obtained by the 14- and 18-month-olds. The 18-month-olds had a significantly larger difference score ($M=29.17\%$) than the 14-month-olds ($M=10.58\%$), $t(54)= - 2.87$, $p<.01$. This suggests that, while infants in both age groups reproduced more intentional than accidental actions, the 18-month-old infants demonstrated a greater ability to differentiate between the action types.

In the third set of analyses, we compared the percentage of intentional and accidental actions completed by the infants (possible range 0-4) out of the total number of

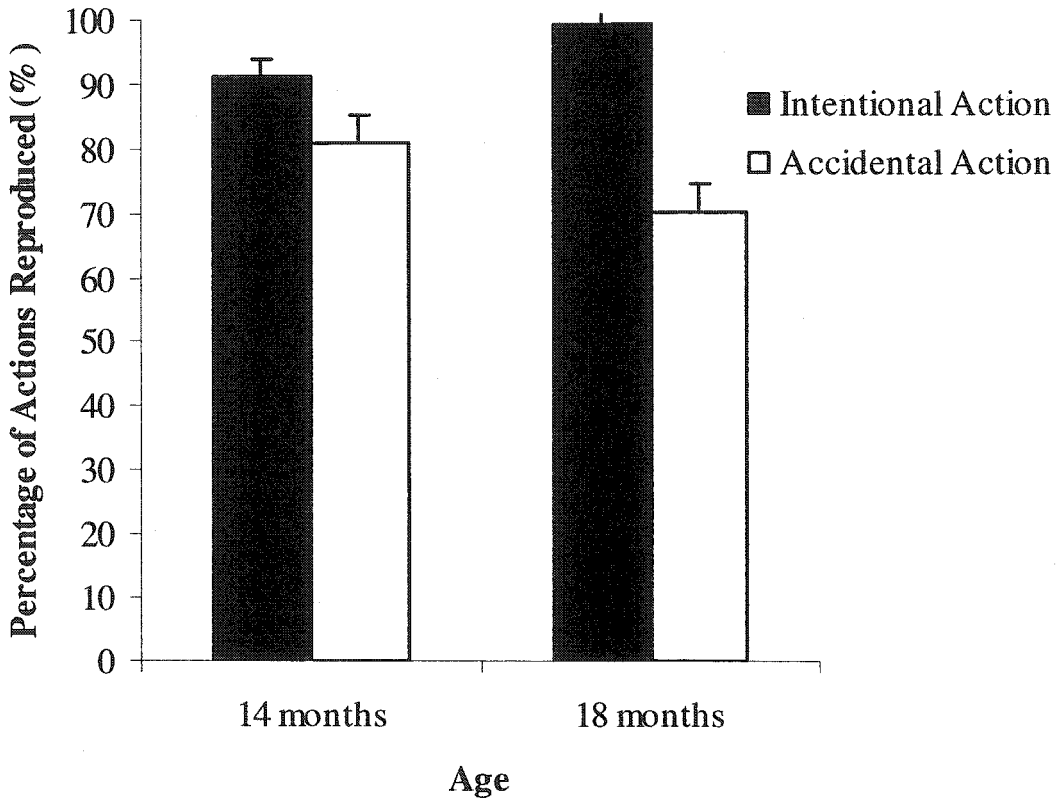

Figure 2. Mean Percentage of intentional and accidental actions reproduced by 14- and 18-month-old infants.

actions they reproduced to chance (50%). The 18-month-old infants reproduced more intentional actions (59.56%) and fewer accidental actions (40.44%) than one would expect given chance alone, $t(29)=7.28$, $p<0.001$. However, the 14-month-old infants did not produce intentional (53.53%) or accidental actions (46.46%) at a rate that differed from what one would expect by chance, $t(25)=1.61$, $p>.05$. These analyses provide further evidence to suggest that, while both age groups had high response rates, only the 18-month-old infants were able to discriminate between intentional and accidental actions.

In the fourth set of analyses, planned contrasts were used to examine whether the infants discriminated between intentional and accidental actions in trials where they only reproduced one of the modeled actions. Independent samples t-tests revealed that there were no significant differences in the number of trials in which 14- and 18-month-old infants reproduced only one action (0.94 and 1.12, respectively), $t(54)= -0.40$, $p>.05$. However, there was a significant difference between the percentage of time the 18-and 14-month-old infants completed the intentional action in trials when they reproduced a single action, $t(54)= -3.67$, $p<0.001$. When 18-month-olds produced one action it was the intentional action 98.91% of the time. However, when 14-month-old infants produced one action it was the intentional action only 73.21% of the time.

Infants were shown the computer animation displays only after they reproduced the intentional action. Therefore, it was important to examine whether their ability to discriminate between intentional and accidental actions improved with repeated exposure to the modeled actions and end result (i.e., were infants trained to reproduce the intentional action). In the fifth set of analyses, a McNemar test for related samples was

computed in order to examine whether there was a difference in the proportion of infants who reproduced the intentional action first on trial one and trial four. If a significantly greater proportion of infants produced the intentional action first on trial four, one could potentially argue that infants had been trained to differentially reproduce this action type. However, the analyses revealed no significant difference between the proportion of 18-month-old infants who reproduced the intentional action first on trial one and the proportion of 18-month-old infants who reproduced the intentional action first on trial four ($\chi^2(1) = 1.22, p>.05$). Furthermore, no difference was found in the proportion of 14-month-old infants who reproduced the intentional action first on trial one and trial four ($\chi^2(1) = 2.48, p>.05$). Thus, infants did not produce more intentional actions simply because they learned the association between these actions and the outcome.

Experiment 2

The primary goal of this experiment was to explore whether 18-month-old infants can also infer the subjective desires of others for objects, and whether there is a link between their understanding of desire and their performance on the previous task. In addition, we were interested in investigating the relationship between infants' early understanding of the mind, their productive vocabulary, and their use of mental terms six months later.

Method

Participants. Twenty-four of the infants who participated in the intention study were included in the final sample (17 females, 7 males; M=18.45 months, SD=0.36; range=17.85 to 19.33). Given that Repacholi and Gopnik's (1997) findings indicated that 14-month-old infants are not yet able to reason about other people's desire for food, only

the 18-month-old infants who participated in the intention task were included in this second experiment. Seven additional infants were tested but were excluded due to excessive fussiness. Also, 10 infants were tested in a pilot study in order to examine the suitability of the stimuli. The infants were recruited from birth lists provided by a public health service office. Nine of the infants included in the final sample were from French-speaking families and the remaining 15 were from English-speaking families.

Materials .For the warm-up task, three objects were presented on a red plastic tray: a toy airplane, a yellow plastic cup, and a rubber duck. The stimuli used for the experimental trials consisted of four pairs of items that were matched as closely as possible for size. To investigate infants' understanding of subjective desires, Repacholi and Gopnik (1997) used food items that were assumed to be appealing (e.g., crackers) and unappealing (e.g., raw broccoli) to the infants. Therefore, in the present study, the experimenters chose objects that were likely be differentially appealing to the infants. Infants' assumed preferences were confirmed in the pilot study. The objects used in the experiment were item pairs consisting of an attractive object and an unattractive object: (a) a dog and a white handle; (b) a car and a hose connector; (c) a horse and a plastic lid; (d) a dump truck and a rubber can gripper (pictures of each of these items are presented in Figure 3). During the task, infants were asked to give the investigator the various items by placing them in a box.

Procedure. The procedure used for the object request task was similar to the food request task used in the study designed by Repacholi and Gopnik (1997). Children were individually tested, seated across a table from the investigator either in a booster chair or on their parent's lap. One camera was used to obtain an audio and visual record of the

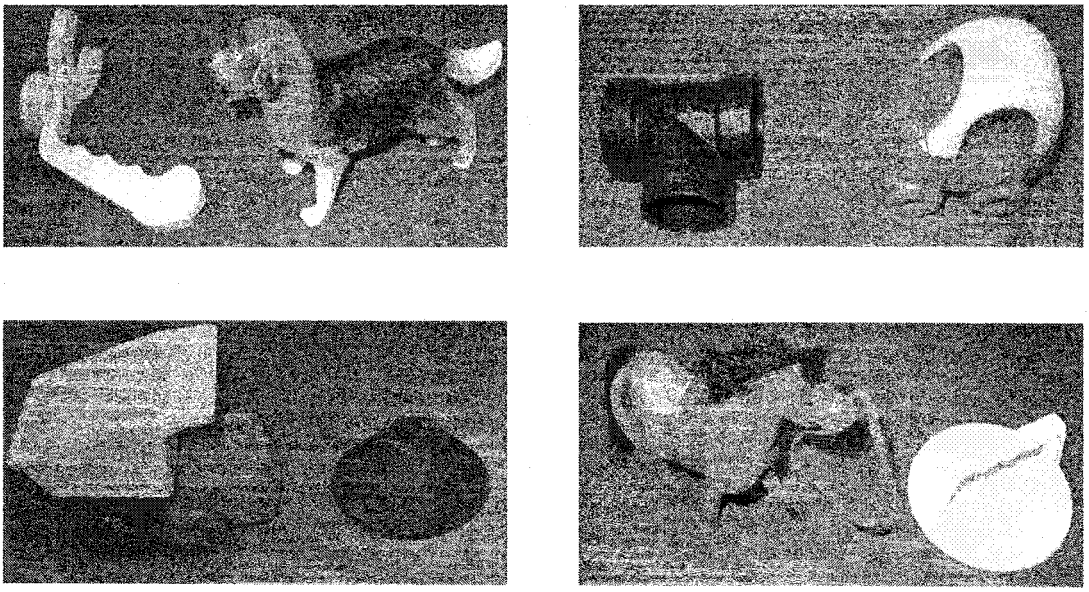

Figure 3. Object pairs consisting of an attractive and unattractive object used in the test phase.

infants' behaviour during testing, while a second camera videotaped the investigator's demonstrations.

The goal of the warm-up phase was to familiarize the infant with the object request task. Infants were presented with three objects (i.e., cup, plane, and duck) on a plastic tray and given 30 seconds to explore the objects. The investigator then asked the infant to give her each of the three items, saying "Okay, give me the cup/plane/duck!" Infants were asked to put the object that was requested in a colourful box. Following compliance, the investigator thanked the infant. Infants were required to give the investigator each of the items before proceeding to the experimental trials.

The four experimental trials were comprised of a baseline phase, a demonstration phase, and a request phase. In the baseline phase, the investigator presented a pair of objects on the tray with each object placed an equal distance from the center of the tray. The investigator placed the tray in front of the infant, saying "Look at these!", and allowed him or her to explore the objects for thirty seconds. The objective of the baseline phase was to (1) familiarize the infant with the objects and (2) to provide an index of the infants' initial object preferences. The items were then removed from the child's immediate reach and the investigator proceeded to the demonstration phase.

In the demonstration phase, the investigator indicated her desire for one object and her dislike of the other object. To indicate her desire, she leaned and pointed toward the object, smiled, and said "Mmm, I like this one, Mmm" while nodding her head. To indicate her dislike, she pushed away from the object with her hand, frowned, and said "Uugh, I don't like this one, Uugh" while shaking her head. In the match condition, the investigator desired the salient object and disliked the boring object. In the mismatch

condition, her preferences were reversed, with the investigator expressing desire towards the boring object and dislike towards the salient object.

After the demonstration, the investigator placed the two objects in front of the infant, held the box above the center of the tray, and said "I want one. Give me the one I want". Following compliance, the infant was thanked and the experimenter proceeded to the next experimental trial. If the infant did not give an object to the experimenter following her initial request, the experimenter placed the objects back on the tray and repeated her request. After all four experimental trials were completed, the infant and parent were taken back to the reception area and infants were given a certificate of merit.

Language Measures. In order to obtain an index of the infants' productive vocabulary, parents were asked to complete the MacArthur Short Form Vocabulary Checklist (Fenson et. al., 2000) or a French version that was adapted by the investigators for the present study. This information was collected during the lab visit and during a follow-up study six months later. During the follow-up study, parents were also contacted by telephone and asked to answer questions regarding the mental terms produced by their child (e.g., want, hope). Specifically, parents were asked if their child's productive vocabulary included desire and belief terms that are typically produced by infants (i.e. first reference of desire between 18 and 30 months of age), as reported in Bartsh and Wellman (1995). See Appendix E for language measures.

Design. In this experiment, all infants were administered two tasks: (1) the intention task outlined in Experiment one and (2) the object request task outlined above. The order in which infants completed these tasks was counterbalanced, such that half the infants completed the intention task first and half the infants completed the object request

task first. The design for the intention task was explained in Experiment one and will not be reiterated here. For the object request task, the four experimental trials were associated with alternating conditions (i.e. match, mismatch). Half the participants began with a mismatch trial and half began with a match trial. Across the four experimental trials, the desired object was presented on the left side for two trials and the right side for two trials. Moreover, the object pairs were presented in four different orders, such that an object pair was equally assigned to the match and mismatch conditions.

Coding and Reliability. Each participant was videotaped and all tapes were coded by the primary investigator. The baseline phase of each trial was coded to examine infants' toy preferences. The time that the infant spent exploring an object was compared to the total amount of time the infant was engaged with the objects. Only behaviours that occurred within the 30 second time limit were coded. The object that infants spent at least 60% of the time exploring was coded as their baseline preference. During the request phase, the object first touched by the infant was coded as well as the object given to the investigator.

In order to establish inter-rater reliability, 20% of the object request data (n=6) was coded by a second coder. There was 99% agreement between coders.

Results

Desire Task. Prior to examining infants' understanding of subjective desires, it was important to verify that their initial object preferences were similar to what had been anticipated by the experimenters. As previously outlined, the match and mismatch conditions were designed with the underlying assumption that infants would prefer the attractive object over the unattractive one. Repacholi and Gopnik (1997) found that

infants preferred the desirable food (i.e., crackers) on 93% of the baseline trials; therefore, very few experimental trials were re-assigned to the match and mismatch conditions. However, in the present study, infants did not demonstrate a strong preference for the attractive object. Contrary to what was expected, infants preferred the attractive object on 59.4% of the trials, the unattractive object on 25% of the trials, and did not demonstrate a preference on 15.6% of the trials. As a result, the present study did not have an equal number of match and mismatch trials. Once infants' baseline preferences were taken into account, there were match trials 51% of the time, mismatch trials 34% of the time, and neutral trials (i.e., no infant preference) 15% of the time. After using infants' preferences to re-assign the match and mismatch conditions, only 29% (n=7) of the infants tested had two match and two mismatch trials.

Consequently, we examined infants' understanding of desire on all 4 experimental trials, regardless of the match and mismatch conditions. We compared the percentage of trials where infants gave the desired object (i.e., number of desired objects given to the experimenter out of a possible four trials) to chance (50%). The analyses revealed that the 18-month-olds did not give the desired object to the investigator at a rate greater than one would expect given chance alone (51.04%), $t(23)= 0.21$, $p>.05$.

However, it was possible that the infants' performance was influenced by the number of requests made by the experimenter. In Repacholi and Gopnik's (1997) investigation, only one food request trial was administered. Thus, in order to compare the results of the present study directly with those reported by Repacholi and Gopnik (1997), we examined infants' performance on their first trial. The proportion of infants who gave the desired object to the investigator (50%) was not different from the

proportion one would expect given chance, $\chi^2(1)=0.00$, ns. Therefore, it appears that the 18-month-old infants were unable to recognize the subjective desires of other's for objects.

Relationship between Infants' Understanding of Intention and Desire. In order to examine how infants' understanding of intention and desire relate, the 18-month-old infants' performance on the intention task was compared with their performance on the desire task. For the intention task, difference scores were used (i.e., difference between the percentage of intentional and accidental actions reproduced) as an index of infants' ability to differentiate between intentional and accidental actions. For the desire task, the percentage of trials in which the desired object was given (out of four trials) was used as the dependent variable.

In the first analysis, infants' performance on the two tasks was correlated. No significant relationship between infants' ability to differentiate between intentional and accidental actions and their understanding of the subjective desires of other people for objects was observed ($r = -.06$, $p>.05$). In the second analysis, a planned contrast was conducted in order to compare the difference scores obtained by infants who either gave or did not give the desired object on the first trial of the object request task. The analysis indicated that infants who gave the desired object on trial one ($n=12$) did not have a higher difference score on the intention task ($M=25\%$) than infants who did not give the desired object on trial one ($n=12$; $M=29.17\%$), $t(22)= - 0.48$, $p>.05$. These results suggest that there is no relationship between infants' understanding of intentions and desires early in the second year of life.

Relationship between Language and Infants' Performance on the Two Tasks. Twenty-one of the infants who participated in both the intention and desire task when they were 18-months-old also participated in a follow-up language study approximately 6 months later (15 females, 6 males; M=24.38 months, SD=0.51; range = 23.23 to 25.66 months). Eleven of the infants were from French-speaking families, and the remaining 10 were from English-speaking families.

Infants' productive vocabulary was measured using either the French or English short forms of the MacArthur Communicative Developmental Inventory. Not surprisingly, participants produced fewer words when they were 18 months of age (M=16.76; SD=9.85; range= 4 to 46) compared to when they were 24 months of age (M=50.62; SD=23.58; range= 12 to 89). Infants' productive vocabulary at 18 and 24 months of age was correlated with the three dependent variables. For the intention task, the dependent measure was the difference scores (i.e., difference between the percentage of intentional and accidental actions reproduced) obtained by the infants. There was no significant relationship between infants' performance on the intention task and their productive vocabulary at 18 (r=-0.10, p>.05) or 24 months of age (r=-0.27, p>.05). For the desire task, the percentage of trials in which the desired object was given (out of four trials) was used as the dependent measure. No relationship was found between infants' performance on the desire task and their productive vocabulary at 18 (r=-0.04, p>.05) or 24 months of age (r=0.27, p>.05). In addition, a composite theory of mind score was derived by adding the number of intentional actions reproduced by the infant to the number of trials in which the desired object was offered (possible range= 0-8). No

relationship was found between infants' composite theory of mind score and their productive vocabulary at 18 (r=-0.04, p>.05) or 24 months of age (r=0.27, p>.05).

Planned contrasts were conducted in order to explore the relationship between infants' mental lexicon at 24-months and their performance on theory of mind tasks at 18-months of age. The 24-month-olds in the present investigation produced very few mental terms (M=0.33; SD=0.48; range= 0 to 1). Infants could be classified into two groups: those who used one desire term (n=7) and those who had not yet begun to use mental terms (n=14). Infants who had produced a mental term (i.e., want) at 24-months of age did not obtain larger difference scores on the intention task than infants who had not yet produced any mental terms, $t(19)$= 0.37, p>.05. Also, infants who had produced a mental term at 24-months did not offer more of the desired objects than infants who had not yet produced a mental term, $t(19)$= 0.89, p>.05. Finally, infants who had used a mental term in everyday conversation at 24-months of age did not obtain greater composite theory of mind scores than infants who had not yet produced a mental term, $t(19)$=0.88, p>.05. The mean scores obtained by both groups of infants (i.e., those who produced a mental term and those who did not) on each dependent variable is presented in Table 1. These results indicate that there is no relationship between infants understanding of intention and desire at 18 months of age and their productive vocabulary, either at the time of testing or 6 months later. Also, there does not appear to be a link between infants' performance on theory mind tasks at 18 months of age and their mental lexicon at 24 months of age.

Table 1

Mean Intention, Desire, and Composite Theory of Mind Scores for Infants Who Either Did or Did Not Produce a Mental Term at 24 Months of Age.

Mental Term Produced at 24 months	Mean Scores Obtained	*M*	*SD*
Yes (n=7)	Difference Score (Intention)	21.43%	22.50
	Total Toys Given (Desire)	53.57%	22.50
	Composite Theory of Mind Score	6.14	0.90
No (n=14)	Difference Score (Intention)	30.36%	20.04
	Total Toys Given (Desire)	51.79%	26.79
	Composite Theory of Mind Score	6.07	1.07

Discussion

There is mounting evidence to suggest that infants have a rudimentary concept of the mind by their second birthday (Flavell, 2000; Wellman, 2002). The primary goal of the present study was to examine whether infants' understanding of intention and desire develops during the second year of life, and whether their understanding of these mental states is related.

In order to investigate whether there is a developmental progression in infants' understanding of intention, the present study compared 14- and 18-month-old infants' ability to differentiate between intentional and accidental action. At first glance, it appeared that both 14- and 18-month-old infants differentiated between intentional and accidental actions and tended to preferentially reproduce the intentional action. However, upon closer inspection, it became evident that there were differences in the level of discrimination demonstrated by the two age groups of infants. Three sets of analyses were conducted in order to explore the possibility of a developmental pattern among 14- and 18-month-old infants' intention understanding.

First, difference scores were computed (i.e., the difference between the percentage of intentional and accidental actions reproduced) in order to examine infants' understanding of intention on an individual basis. The analyses revealed that, on average, older infants obtained a substantially greater difference score (29.17%) than younger infants (10.58%). The larger difference scores obtained by the older infants suggest that 18-month-olds differentiate between accidental and intentional actions to a greater extent than 14-month-olds. Second, we compared infants' tendency to reproduce intentional and accidental actions relative to the number of actions completed overall. While the 18-

month-old infants reproduced more intentional and less accidental actions than expected by chance, the 14-month-olds did not. Thus, when we took into account the number of actions infants reproduced overall, the 14-month-old infants did not discriminate between the two action types above chance levels. Finally, we examined infants' tendency to reproduce the intentional action on trials where they only performed one action. Although there were no differences in the number of trials in which the 14- and 18-month old infants reproduced only one action, there were differences in their preference for the intentional action. When 18-month-old infants reproduced a single action, it was the intentional action almost every time (98.91%). However, when 14-month-olds reproduced a single action it was the intentional action less often (73.21%).

One criticism of the present study is that infants may have been trained to differentially produce the intentional action because of the link between this action and the end result (i.e., computer animation). A related possibility is that the older infants were better at the intention task than the younger infants, simply because they learned the association between the outcome and the intentional action more efficiently. If this were the case, infants should produce the intentional action first more often on their last experimental trial. However, analyses did not reveal this learning pattern for either age group of infants. The results of the present study suggest that, while 14-month-old infants have a nascent understanding of intention, their ability to differentiate between intentional and accidental actions is not as well-developed as 18-month-old infants.

These findings contribute important information to what is known about infants' early concept of intentionality. Our results replicate and add to the existing evidence which suggests that 18-month-old infants can discriminate between intentional and

accidental actions, prefer to reproduce intentional actions, and can infer the goals underlying human behaviour (Carpenter et. al, 1998; Meltzoff, 1995). Our results indicate that 14-month-old infants' understanding of intention is less refined than the understanding demonstrated by older infants, which is consistent with previous research. For instance, 12-month-olds are unable to infer intentions, and 15-month-olds incorrectly generalize their attributions of intentions to nonhuman agents possessing human characteristics (Bellagamba & Tomasello, 1999; Johnson, Booth & O'Hearn, 2001). Thus, while there does not appear to be a complete developmental shift in infants understanding of intention between 14 and 18 months of age, our results provide evidence to suggest that there is a developmental progression, with 18-month-old infants demonstrating a more advanced understanding of intention than 14-month-old infants.

The present study also explored 18-month-olds' understanding of subjective desires. There is evidence to suggest that 18-month-old infants can infer the subjective desires of others for food (Repacholi & Gopnik, 1997). Therefore, in the present experiment, our aim was to elucidate whether this understanding could be extended to objects. Overall, 18-month-old infants did not give the experimenter the desired object above chance levels. In Repacholi and Gopnik's (1997) investigation, only one request trial was administered; therefore, we also examined infants' response on the first trial. Still, the proportion of infants who gave the desired object did not exceed chance.

In the investigation by Repacholi and Gopnik (1997), infants' preferences at baseline were almost always consistent with the experimenter's expectations (i.e., infants preferred crackers 93% of the time). However, in the present study, infants' preferences were not as consistent with the experimenter's expectations. Infants sometimes preferred

the attractive object, sometimes preferred the unattractive object, and sometimes did not exhibit a clear preference for either object presented in the pair. Therefore, we did not have an equal number of match and mismatch trials for each child, and were unable to compare infants' understanding of desire in each of these conditions. Rather than having match trials half the time and mismatch trials the other half of the time, the present study had match trials 51% of the time, mismatch trials 34% of the time, and neutral trials (i.e., no infant preference) 15% of the time. Given that the mismatch trials are more difficult because infants are required to infer desires that are contrary to their own, the present study should have been less challenging than Repacholi and Gopnik's (1997) task.

However, as stated earlier, infants were unable to infer subjective desires in the present study. Their poor performance can not be attributed to non-compliance, as the attrition rate of the present study was significantly lower (12%) than the 30% non-compliance rate reported by Repacholi and Gopnik (1997). One methodological limitation that may have negatively impacted infants' desire reasoning was their lack of a clear preference for the attractive objects during baseline trials. It is possible that infants were unable to infer the subjective desires for objects because they did not have strong preferences; therefore, they were not convinced by the experimenter's expressed emotions. It is possible that infants were better able to infer the subjective desire of others' in Repacholi and Gopnik's (1997) study because they of their expectations regarding what the experimenter would like. In match trials, infants may have been better able to relate to the experimenters' desires and in mismatch trials they may have been more likely to remember the experimenter's desire because it was so contrary to their own.

Nonetheless, the results of the present experiment suggest that infants are unable to infer the subjective desires of other people for objects. Our findings replicate and extend the results of McKoy and Poulin-Dubois (1999), who also found that 18-month-old infants' ability to infer the subjective desires of others could not be extended from food to objects. These experiments seem to indicate that infants' understanding of subjective desire is fragile at 18-months and may be specific to food. However, these results are inconsistent with research that has examined 18-month-olds' understanding of desire using the preferential looking paradigm. Tilden, Poulin-Dubois, and Desroches (as cited in Poulin-Dubois, 1999) found that 18-month-olds understand desires, as well as the link between emotion and desire fulfillment (i.e., people look happy when their desire is fulfilled and sad when it is not). It is possible that the infants in the present study failed to demonstrate an understanding of desire because the request procedure is more demanding. Unlike infants in the experiment conducted by Tilden, Poulin-Dubois, and Desroches (as cited in Poulin-Dubois, 1999) who simply watched movies of expressed desires and outcomes, infants in the present study had to infer the examiner's desire and produce a response. Given the inconsistent results, more research is needed to shed light on infants' early concept of the mental state of desire.

In order to explore whether there is a relationship between infants' early understanding of intention and desire, the present study examined 18-month-old infants' performance on the two tasks described above. Given that independent studies have shown that infants as young as 18-months have some understanding of intention and desire, it was expected that there would be a link between their performances on tasks tapping into intention and desire understanding. For instance, infants who demonstrated

a well-developed ability to differentiate between intentional and accidental actions were also expected to demonstrate a greater ability to infer subjective desires of others. However, there was no significant relationship found between the 18-month-old infants' performance on the two tasks. It is likely that the lack of variation in infants' performance on the intention task contributed to the null result.

To our knowledge, there have been no other studies exploring the relationship between infants' understanding of different mental states. However, we can compare our results with what has been documented in research with older children. There is evidence to suggest that 4-year-olds' performances on different theory of mind tasks are related (e.g., Gopnik & Astington, 1988; Ruffman, Olson, Ash, & Keenan, 1993; Polak & Harris, 1999). Moreover, recent research has provided evidence to suggest that infants' understanding of emotions and actions, as measured by a preferential looking task, is positively correlated with their performance on theory of mind tasks at 4 years of age (Wellman, Phillips, Dunphy-Lelii, & Lalonde, 2003). Given the lack of variability among 18-month-olds' performance on the intention and desire tasks employed in the present study, future research should examine the relationship between infants' understanding of these internal states by comparing infants' performance on alternative tasks. For instance, one might compare infants' desire understanding as measured by a preferential looking task (e.g. Poulin-Dubois, 1999) with their intention understanding as measured by a novel word learning experiment (e.g., Tomasello & Barton, 1994).

An additional aim of the present study was to investigate the relationship between infants' language and their early understanding of the mind. To this end, parents of the 18-month-olds were contacted shortly after the infants' second birthday and asked to

provide information regarding the words used by their toddlers during everyday conversation. There was no relationship between infants' general productive vocabulary at time of testing and their performance on either task. This finding is consistent with other research which has explored the relationship between infants' productive vocabulary and performance on tasks tapping into theory of mind (e.g., Carpenter et. al., 1998; Repacholi & Gopnik, 1997). We also examined the relationship between infants' understanding of intention and desire at 18-months and their productive vocabulary and mental lexicon at 24 months of age. There was no relationship between infants' general productive vocabulary at 24 months of age and their performance on theory of mind tasks six months earlier. The 24-month-olds in the present investigation could be classified into two groups: those who used one desire term (i.e., want), or those who had not yet begun to use desire terms. Their limited mental lexicon is consistent with evidence that has suggested that, although infants produce their first mental term between the ages of 18 and 30 months, it is only at the age of 28 months that the majority of children have used their first mental term in everyday conversation (Bartsch & Wellman, 1995). Our results indicated that there were no differences between these groups of infants on their performance on the intention and desire tasks. It is likely that these null effects are due to the lack of variability among infants' performance on the tasks, and the limited mental lexicon at 24 months. Therefore, results from the present investigation suggest that infants' performance on theory of mind tasks at 18-months of age is not related to their general productive language or their mental lexicon at the time of their second birthday. Given that children have a larger mental lexicon by 3 years of age, it would be interesting

to explore whether a relationship exists between infants' performance on the theory of mind tasks at 18-months and their mental lexicon at approximately 36 months of age.

Taken together, the results of the present studies contribute to research outlining the origins of theory of mind in infancy. According to our findings, there may be a developmental progression early in the second year of life, with 18-month-olds demonstrating a more advanced understanding of intention than 14-month-olds. Overall, 18-month-old infants in the present investigation were unable to infer subjective desires for objects. Our findings suggest that 18-month-old infants' understanding of subjective desire is fragile, and may be food specific. However, researchers using the preferential looking paradigm have suggested that 18-month-old infants understand desire for objects and the link between emotion and desire fulfillment (Tilden, Poulin-Dubois, & Desroches, as cited in Poulin-Dubois, 1999). These seemingly inconsistent findings may be a result of the varying demands of the methodology employed. Therefore, additional research is needed to explore the emergence of desire understanding in infancy. Finally, the results of these studies indicate that further experiments are required in order to elucidate the relationship between infants' understanding of intention and desire, and the link between theory of mind and language.

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Appendix A

Recruitment Letters

Concordia
UNIVERSITY

July 2002

Dear parents,

The Child Development Laboratory at Concordia University is involved in a series of studies looking at how infants learn about people's intentions and desires. This research is funded by the Natural Sciences and Engineering Research Council of Canada. The Commission d'Accès à l'Information du Québec has kindly given us permission to consult birthlists provided by the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre. Your name appears on the birthlist of May 2001 which indicates that you have a child of an age appropriate for our study.

The present investigation involves two tasks. In the first task, we are examining infants' ability to differentiate between intentional and accidental actions of others. To do this, we will model a sequence of both accidental and intentional actions, using toy devices, in order to activate a computer animation display. We will then give your child the opportunity to repeat the action sequence using the same devices. The second task has been designed to examine infants' ability to recognize the preferences of others. We will show your child pairs of toys in which one toy will be very attractive to the infant (e.g. toy car) and the other will not (e.g. honey dipper). The experimenter will then display expected and unexpected emotions towards the toys (i.e. will show excitement towards the honey dipper and negative emotion towards the toy car). Then, your child will be asked to give the experimenter the toy that she wants. During both studies, your child will be sitting in a child seat and you will be seated directly behind. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality. In addition to these tasks, we are interested in examining whether infants' vocabulary is related to their behavior during these tasks. We will be asking you to complete a short questionnaire regarding the words that your child is currently producing.

Participation involves one visit of approximately one hour to our research centre on the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West. Appointments can be scheduled at a time convenient to you, including weekends. Free parking is available on the campus for our participants, and we will gladly reimburse any transportation expenses at the time of your appointment. Upon completion of the study, a Certificate of Merit will be given to your child, and a report of the results of the study will be mailed to you as soon as it is completed.

For the purpose of the this study, we are looking for infants whose parents speak French or English at home, and who have no visual or auditory difficulties. If you are interested in having your child participate in this study, or would like further information, please contact Samantha Nayer or Kara Olineck at 848-2279. We will try to contact you by telephone after receipt of this letter.

Thank you for your collaboration,

Diane Poulin-Dubois, Ph. D.
Professor
Department of Psychology

Kara Olineck, B.A.
M.A. Candidate

Samantha Nayer, B.A.
Research Assistant

7141 Sherbrooke Street West, Montreal, Quebec, Canada H4B 1R6

Concordia
UNIVERSITY

November 2002

Dear Parents,

Once again, we would like to thank you for participating this summer in our research study on infants' understanding of other people's mental states. As you may recall, we are interested in whether a relationship exists between 18-month-olds' understanding of other peoples' mental states and the types of words they are able to produce at two years of age.

As such, we have attached a brief questionnaire concerning your child's vocabulary. We would very much appreciate it if you could fill out the questionnaire when your child reaches twenty-four months of age and return it to us in the envelope provided. If your child has already had his or her second birthday, we would greatly appreciate it if you could fill out this questionnaire at your earliest convenience. Children learn words at a fast rate so it is very important that you record your child's productive vocabulary as close to his/her second birthday as possible. Additionally, we will be contacting you by telephone shortly in order to ask some brief questions regarding the words that your child is currently using.

Thank you for your cooperation and interest in our research project. Research on children's early cognitive development is only possible thanks to the contribution of time and effort by families like you. If you would like further information about the results of this study, or have any questions about issues concerning cognitive development, please do not hesitate to contact either Kara Olineck at 848-2279 or Dr. Diane Poulin-Dubois at 848-2219.

We are looking forward to talking with you in the near future.

Sincerely yours,

Diane Poulin-Dubois, Ph.D.
Professor
Department of Psychology

Kara Olineck, B.A.
M.A. Candidate
Department of Psychology

Appendix B

Consent Forms

Parental Consent Form

The present investigation involves two tasks. In the first task, we are examining infants' ability to differentiate between intentional and accidental actions of others. To do this, we will model a sequence of both accidental and intentional actions, using toy devices, in order to activate a computer animation display. We will then give your child the opportunity to repeat the action sequence using the same devices. The second task has been designed to examine infants' ability to recognize the preferences of others. We will show your child pairs of toys in which one toy will be very attractive to the infant (e.g. toy car) and the other will not (e.g. honey dipper). The experimenter will then display unexpected emotions towards the toys (i.e. will show excitement towards the honey dipper and negative emotion towards the toy car). Then, your child will be asked to give the experimenter the toy that she wants. You will be present throughout the experimental session but we ask that you remain silent and neutral. The entire session is expected to last approximately forty minutes.

Diane Poulin-Dubois, Ph.D.
Professor

Kara Olineck, B.A. (hons)
M.A. 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 experimenter will gladly answer any questions that might arise during the course of the research.

_____ _____
Parent's signature Date

I would be interested in participating in the follow up vocabulary study with my child (yes/ no): _____

I would be interested in participating in other studies with my child in the future (yes/ no): _____

Participant # _____ Researcher: _____

Parental Consent Form

In the present experiment, we are examining infants' ability to differentiate between intentional and accidental actions of others. To do this, we will model a sequence of both accidental and intentional actions, using toy devices, in order to activate a computer animation display. We will then give your child the opportunity to repeat the action sequence using the same devices.

You will be present throughout the experimental session but we ask that you remain silent and neutral. The entire session is expected to last approximately thirty minutes.

Diane Poulin-Dubois, Ph.D.
Professor

Kara Olineck, B.A. (hons)
M.A. 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 experimenter will gladly answer any questions that might arise during the course of the research.

_____ _____
Parent's signature Date

I would be interested in participating in other studies with my child in the future (yes/ no): _____

Participant # _____ Researcher: _____

Appendix C

Demographic Questionnaire

Participant Information

Infant's name:_____ Date of Birth: _____

Gender:_____ Language(s) spoken at home:_____

Mother's name: _____ Father's name: _____

Address: _____ Telephone #: _____home

_____ _____work

Postal Code:_____ _____work

Mother's occupation:_____ Father's occupation:_____

Mother's education (highest level attained):_____

Father's education (highest level attained):_____

Mother's marital status:_____ Father's marital status:_____

Please answer the following general information questions about your child:

Birth weight:_____ Length of pregnancy:_____weeks

Birth order:_____(e.g., 1 = 1st child)

Number of siblings:_____

Were there any complications during the pregnancy?_____

Has your child had any major medical problems?_____

Does your child have any hearing or vision problems? _____

Please answer the following general information questions about your family:

Does your family have a pet (or pets)? (yes/no) _____ If you answered yes, please list your pet(s) indicating the kind of pet(s) (e.g., dog, cat, fish) and the number of pets:

_____

Participant#:_____ Researcher:_____

Appendix D

Instructions Given to Parents

Instructions for Parents

1. When we enter the room where will be doing the study, please seat your child in the infant seat and sit behind your child in the chair provided.

2. Before we begin the task, please ensure that your infant has no toys or food, as these items may be distracting.

3. If possible, do not say anything and do not touch your child during the length of the experiment (about 20 minutes). Please do not point or call attention to any of the toys during the study.

4. During the experiment, your child will probably turn around and look at you a few times. If this occurs, you may respond by smiling, but please try not to say anything.

5. If your child becomes very fussy or starts to cry, we will pause the experiment to give you a chance to comfort him/her.

Appendix E

Language Measures

MacArthur Short Form
Vocabulary Checklist: Level II (Form A)

Make no stray marks.
Erase any changes cleanly.

Improper Marks ⊘ ⊗ ◒ ⊙

Proper Mark ●

Child's Name _____ Sex _____

Birthdate _____ Today's Date _____

VOCABULARY CHECKLIST

Children understand many more words than they say. We are particularly interested in the words your child SAYS. Please mark the words you have heard your child use. If your child uses a different pronunciation of a word, mark it anyway.

baa baa ○	hat ○	sky ○	all gone ○
meow ○	necklace ○	party ○	cold ○
ouch ○	shoe ○	friend ○	fast ○
uh oh ○	sock ○	mommy ○	happy ○
woof woof ○	chin ○	person ○	hot ○
bear ○	ear ○	bye ○	last ○
bird ○	hand ○	hi ○	tiny ○
cat ○	leg ○	no ○	wet ○
dog ○	broom ○	shopping ○	after ○
duck ○	comb ○	thank you ○	day ○
horse ○	mop ○	carry ○	tonight ○
airplane ○	plate ○	chase ○	our ○
boat ○	trash ○	dump ○	them ○
car ○	tray ○	finish ○	this ○
ball ○	towel ○	fit ○	us ○
book ○	bed ○	hug ○	where ○
game ○	bedroom ○	listen ○	beside ○
applesauce ○	bench ○	like ○	down ○
candy ○	oven ○	pretend ○	under ○
coke ○	stairs ○	rip ○	all ○
cracker ○	flag ○	shake ○	much ○
juice ○	rain ○	taste ○	could ○
meat ○	star ○	gentle ○	need ○
milk ○	swing ○	think ○	would ○
peas ○	school ○	wish ○	if ○

Has your child begun to combine words yet, such as "nother cookie" or "doggie bite?"

○ Not Yet ○ Sometimes ○ Often

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Mental Lexicon Inventory: Desire and Belief Terms

Subject #: _____

Contact Name: _____

Child's name: _____ D.O.B.: _____

Date called: _____ Phone number: _____

Notes:

Desire Terms

1. **WANT** (wants, wanted, wanna)
Definition: Desire as expression of intention or goal directed action.
For example: I want to see Elmo. Don't want to sleep.
Exclusions : want-as-request for available object (e.g., I want an apple)

2. **HOPE**
Definition: Desire not in relation to a precise action.
For example: I hope Santa comes at Christmas.
Exclusions: In conversation for indirect demands (e.g., I hope I am not bothering you)

3. **WISH**
Definition: Expression of desire for something that cannot be obtained.
For example: I wish I could play with this.
Exclusions: Used in conversation for an indirect request (e.g., I wish you would stop talking)

4. **CARE**
Definition: Preference or lack of preference.
For example: I don't care if we go to McDonald's. I don't care that you are bothering me.
Exclusions: Taking care of, caring for

5. **AFRAID** (about)
Definition: Only included if word is in proposition.
For example: I'm afraid it's going to rain.
Exclusions: Expressions of being afraid (e.g., I'm afraid of rats)

Belief Terms

1. **THINK**
(a) Thought-as-belief.
Definition: Using think to refer to a propositional belief state.
For example: He thinks this is a monster. He thinks this is a real one.

(b) Thought-as-imagination.
Definition: Referring to a mental state that is fictional or imaginary.
For example: I thought my doll was superman.

(c) Thought-as-activity.
Definition: Referring to mental activity, to a mental process.
For example: I'm thinking about my brother.

EXCLUSIONS FOR THINK: I think we should go. I think so. I think not. What do you think.

2. KNOW
Definition: Refers to stating a belief that is justified or true.
For example: You don't know where the pieces go. I know.

EXCLUSIONS FOR KNOW: To refer to a familiarity with something or someone (e.g., I know Mary, I know how to tie my shoes)

3. **BELIEVE**
Definition: To talk about states of conviction in, or endorsement.
For example: Make believe this is a crib. He believes in witches.

4. WONDER
Definition: Refers to the psychological sate of not knowing yet speculating about something.
For example: I wonder what that is?

5. DREAM
Definition: Refers to special contentful mental states while asleep or to wishes.
For example: I dreamed about being able to fly.

6. EXPECT
Definition: References to not knowing for sure, but believing or anticipating something.
For example: I expect to see lions at the zoo.

Appendix F

ANOVA Source Table

Table F1

Source Table for Analyses Comparing 14- and 18-month-old Infants' production of Intentional and Accidental Actions (Age group by Action type ANOVA).

Source	*df*	*F*
Between subjects		
Age group	1	0.158
Within-group error	54	(382.063)
Within subjects		
Action type	1	37.632*
Action type x Age group	1	8.233*
Within-group error	54	(292.32)

Note. Values in parentheses represent mean square errors; asterisks indicate $p < .05$.