

Running Head: DISCRIMINATION OF UNWILLING VERSUS UNABLE PARTNERS

Six- and nine- month-old infants discriminate between goals despite similar action patterns

Heidi L. Marsh, Jennifer Stavropoulos, Tom Nienhuis, and Maria Legerstee

York University, Toronto, Canada

Keywords: object and goal-directed actions, socio-cognitive development

Acknowledgements: This research was supported by grants from the Social Sciences and Humanities Research Council (Canada) to Maria Legerstee and an Ontario Graduate scholarship to Heidi Marsh. Gratitude is expressed to the infants and parents who participated in the studies and to the research team of the Centre for Infancy studies at York University for their help with the research reported here. Contact address: Heidi Marsh: hmarsh@yorku.ca

Abstract

Behne, Carpenter, Call, and Tomasello (2005) showed that 9-18 month-olds, but not 6-month-olds, differentiated between people who were unwilling and unable to share toys. Because the outcome of the two tasks is the same (i.e., the toy is not shared), the infants must respond to the different goals of the actor. However, visual habituation paradigms have shown an earlier onset of goal awareness. The present study reconciles this disparity by replicating the findings of Behne et al. with both 6- and 9-month-olds, using similar tasks and additional response measures.

Six- and nine- month-old infants discriminate between goals despite similar action patterns

From birth, infants are particularly attracted to agents that act intentionally (Legerstee, Ellenbogen, Nienhuis, & Marsh, *in press*; Trevarthen, 1979). They attend to faces, eyes, voices, and body movements (Legerstee & Varghese, 2001; Markova & Legerstee, 2006), and engage in imitative games with them (Meltzoff & Moore, 1977; Legerstee, 1991). However, one cannot conclude from these attention biases that infants comprehend the intentionality that underlies these actions. One way to determine if this ability exists is to examine whether or not infants are aware of the underlying causality of people's behavior.

For instance, using visual habituation, it has been shown that infants appreciate the goal directedness of successful actions during their first year (Barna & Legerstee, 2005; Phillips, Wellman & Spelke, 2002; Woodward, 1998). Moreover, 6-month-old infants interpret human but not non-human actions as goal-directed (e.g., Woodward, 1998). However, this evidence does not necessarily reveal an awareness of internal goals, because infants might focus solely on the outcome, and thus perceive the actions of people to be no more than just behavioral or bodily movements. Studies on the development of an awareness of internal goals need to utilize paradigms that involve *unsuccessful* or *invisible* outcomes, because they separate the outcome from the underlying goal. In one such 'unsuccessful action' study using visual habituation, 10- and 12-month-olds inferred the goal directedness of both successful and unsuccessful reaching actions, but eight-month olds only recognized the goal directedness of successful actions (Brandone & Wellman, 2009). In contrast, Hamlin, Newman & Wynn, (*in press*) also used visual habituation, but revealed that 8-month-olds inferred unfulfilled goals, (placing a ring on a tower) by human, but not inanimate agents, which fits visual habituation data by Legerstee, Barna & DiAdamo (2000), with 6-month-olds.

Imitation of incomplete actions is viewed as a definitive test of goal-directed understanding, because it avoids the limitations of visual attention paradigms, such as the possibility of a simple reaction to novelty effects. Given that between 9 and 12 months infants begin to imitate novel and combined action sequences (Meltzoff, 1988; Want & Harris, 2002), Legerstee & Markova (2008) explored whether 10 month-old infants were able to re-enact an unseen goal. Infants saw a human agent, a non-human agent (stuffed animal) and a surrogate object (mechanical pincers) model actions on objects. Infants imitated the successful actions of human and non-human agents, (but not of the surrogate object), and completed the unsuccessful actions of humans only. These findings were replicated with 7-month old infants who reproduced an actor's unfulfilled goal to reach a particular object in a simplified imitation task (Hamlin, Hallinan, & Woodward, 2008).

Despite evidence of goal attribution in younger infants, Behne et al. (2005) found evidence to the contrary, using a different interactive paradigm. Nine, 12 and 18-month-olds, but not 6-month-olds, reacted differently when an adult was unwilling rather than unable to pass a toy, despite similar outcomes (the toy was not shared), and perceptual matching of conditions. Null results do not mean that a particular understanding does not exist. It is possible that Behne et al. (2005) focused on infants' conventional communicative response measures, whereas at 6 months, infants use more stylized communicative responses when attributing object-directed goals to others (Mosier & Rogoff, 1994; Hardy, 1982). For instance, 6 month-olds use affective responses and instrumental reaches when trying to get access to a toy in challenging situations, such as when mothers hold toys out of their infants' reach (Crais, Douglas, & Campbell, 2004; Mosier & Rogoff, 1994). Therefore, to examine whether 6-month-old infants are aware of a social partner's unwillingness versus inability to share toys, we used similar tasks as Behne et al., but employed additional behavioral measures, such as gaze aversions and affective behaviors.

Method

Participants

Forty-six infants were recruited. Three 6- and three 9-month-olds were not included due to experimental error (one 6-month-old), or infant fussiness (tired, burping, etc.) (two 6-, three 9-month-olds). There was no systematic pattern in infant exclusions with respect to experimental conditions, infant gender, or age. The final sample comprised forty infants, including twenty 6-month-olds (10 girls, $M = 6$ months, 9 days; range = 5 months, 3 days to 7 months, 20 days) and twenty 9-month-olds (11 girls, $M = 8$ months 27 days; range = 8 months 2 days to 10 months 2 days). Infants came from mixed socioeconomic classes, determined by parental years of education.

Materials and Procedure

Infants were seated in their mothers' lap at a small table (82cm x 71cm) within a half circle that had been cut out on one side, facilitating infant actions. The table was placed in a rectangular room (3 x 5 m). Mothers supported infants by the waist to keep them in an upright position, and were asked not to interact with their infants. The experimenter (E) sat across from the participants. A camera recorded experimental sessions from behind an occluder. The camera was situated beside and slightly behind E, and focused on the infant's face and upper body. Sessions were recorded on a VCR with a date and time recorder, to facilitate coding of the behavioral measures.

Before the test trials began, infants engaged in a 3-minute familiarization session with E. Testing began when infants were in a calm and alert state (Stage 4; Wolff, 1966). E would examine a toy, draw the infant's attention to it, and pass the toy to the infant when the infant looked at it or E. Before a new toy was introduced, the previous toy was put out of sight. Interspersed within this cycle of toy-sharing were test trials when the toy was not passed. In half

of the test trials, the toy was not passed to the infant because E was *unwilling* to share it, and in the others, it was not passed because E was trying, but *unable* to pass it. Infants were administered three tasks (Block, Mock, and Play), each with a corresponding unwilling and unable condition, for a total of 3 unwilling and 3 unable trials. The Mock task was similar to the ‘Tease’ task in Behne et al. (2005), whereas the Block and Play tasks were modified slightly from the ‘Refuse’ and ‘Play’ tasks, to preclude the use of jars, with which infants may have limited experience.

1) *Block*. A transparent plexi-glass ‘wall’ (81.5 cm in height) with a hole in the centre (4.5 cm in diameter) was erected on top of the table, 24 cm from E (blocking E and the infant from one another). The task began with E sharing a small rattle with the infant through the hole. Then, E showed a new toy but did not share it for one of two reasons. In the unwilling condition, E refused to pass a ball to the infant, and instead played with it herself, rolling it toward the plexiglass and back. In the unable condition, E repeatedly tried to pass a cubic squeaky toy to the infant, but it would not fit through the hole in the plexi-glass.

2) *Mock*. The table was slightly tilted with supports, so that toys would roll back toward E if they landed on the surface. E began by sharing a toy with the infant. During the test conditions the toy was not shared. In the unwilling condition, a rattle was held out to the infant, but was pulled back in a teasing manner when the infant reached for it. In the unable condition, E held a ball out toward the infant, but ‘accidentally’ dropped it when the infant reached for it. When the ball rolled back to E, she tried passing the ball again.

3) *Play*. During Play, E played with a jack-in-the-box, a wind-up toy, and a remote-control toy. During toy-sharing, E operated the toy in the middle of the table while the infant watched, so that they interacted together with it. In the unwilling condition, E kept her hands around the toy as she operated it selfishly on her side of the table, preventing the infant from

interacting with it. In the unable condition, E held the toy as she tried to operate it, but could not get it to work (e.g., by exaggeratedly pressing the button, or turning the crank, to no effect). In both conditions, infants did not see the toy in operation.

After Behne et al. (2005), E's pattern of body movements and direction of gaze between the unwilling and unable conditions were matched (see Table 1), to preclude the chance that infants' differential responses were due to these cues. We also matched the location and direction of movements of the toys, including final location, to prevent responses to the movement of the toy alone.

Although E's body movements were matched across conditions, E conveyed different emotional expressions, because they are important cues to infer E's goals. E showed neutral expressions during toy-sharing, teasing smiles during unwilling trials, and frustration and surprise during unable trials (c.f. Behne et al., 2005). This should not confound results, because E showed positive expressions during unwilling and negative expressions during unable, whereas infants were expected to respond with positive expressions in the unable and negative expressions in the unwilling conditions.

Order of trials was counterbalanced within and between participants, except that the Block task was always performed first, because of changing the plexi-glass partition. Each trial lasted 30 seconds, during which E performed the actions 4-5 times. Infants could no longer participate if they ceased to engage, because of the interactive nature of the toy-sharing game. To ensure infants were engaged, E only passed a toy once infants made eye contact with either E or the toy. After E repeatedly tried to get the infants' attention, including calling their name without success, infants were deemed to have lost interest. Three attempts were made before naïve observers, who filmed the interaction in a separate room, decided to cease testing. One six- and one nine-month-old completed the Block and Mock tasks, but lost interest before the beginning

of the Play task. Data from the other tasks was included in the final sample.

Measures

Behaviors were recorded in duration (seconds), except for banging, which was measured in frequency.

Arm gestures. Two arm gestures were recorded. Banging was coded when infants lowered one or both hands onto the table to create an audible effect. Sounds that resulted from infants lowering their hands after reaching, and those from leaning or crawling on the table, were not included as banging. Reaching was coded when infants extended their arms toward the toy while looking at it or at E, and lasted until they pulled back. Mosier & Rogoff (1994) found that 6-9 month-old infants reached toward their mothers to elicit their assistance in operating toys. They termed these ‘instrumental reaches’, in contrast to ‘psychological reaches’, produced by older children when the adult prevented the child from accessing a toy. Therefore, if infants were aware that E was unable to share, then they might attempt to change the *physical* environment rather than the psychological one (the unable rather than the unwilling adult). Consequently, we expected to see more reaches in the unable condition, as an attempt to facilitate E’s anticipated passing of the toy, than in the unwilling condition.

Gaze aversion. Gaze aversions rather than ‘looks away’ were coded. Behne et al. coded ‘looks away’, which included all instances of looking away from E and the toy. In contrast, gaze aversions were coded when infants lowered their eyelids, without closing, followed by a diversion of the gaze to the side and reveal infant frustration and embarrassment, when adults are unwilling to communicate in the still-face paradigm (Tronick, Als, Adamson, Wise & Brazelton, 1978; Legerstee & Varghese, 2001),

Affective behaviors. Durations of infants’ negative vocalizations (forced or effortful vowel-like sounds, with nasal tone and uniform pitch) and negative facial expressions (mouth,

eyebrows, and cheeks turned down), were coded to evaluate infant frustration. Durations of infants' positive vocalizations (cooing sounds, containing varied pitch contours) and facial expressions (corner of lips rounded upwards, with mouth open or closed) were coded to evaluate infant happiness. Vocalizations and facial expressions were not mutually exclusive, and were recorded under the umbrella term of negative or positive affect. If a negative vocalization and frown occurred at the same time, this was counted as a single occurrence (Hsu & Fogel, 2003).

Coding and Reliability

Behavior was coded during response periods, by a coder blind to experimental hypotheses and conditions. A second blind observer independently coded 20% of the infants (4 in each age group). Test trials were recorded to the nearest second, using the time imprinted on the video. Data from trials that were not 30 seconds were converted to a 30-second scale using proportions. To assess inter-rater reliability, two-way mixed effects intraclass correlations were calculated using an absolute agreement definition. Reliability was significant for all behaviors ($p \leq 0.001$), with values ranging from 0.802 (gaze aversion) to 0.972 (banging).

Data analysis

Non-parametric analyses (Wilcoxon signed-ranks tests; alpha level of .05) were performed for individual groups, because the data failed to meet the assumptions of parametric tests (cf. Behne et al., 2005; Crais et al., 2004). The data from at least one of every matched pair of conditions had distributions with skewness values greater than twice the standard error (Mean skewness value = 2.05, Range = 0.12 to 4.47). Moreover, Shapiro-Wilk tests found significant deviations from normality in 51 of the 60 distributions ($p < .05$).

Results

Six and 9- month-olds showed systematic discrimination between the unwilling and unable conditions across a number of behavioral measures. Descriptive statistics and significant

findings are summarized in Figures 1-3, and the results of the Wilcoxon tests are summarized in Table 3. Key trends are discussed below.

Arm Gestures

During the Block and Mock tasks, nine, but not 6 month-olds, banged their arms significantly more in the unwilling than unable Mock condition. The 6- and 9- month-olds produced significantly more reaching during unable than unwilling conditions (Figure 1). Similar trends for the Play task were not significant.

Gaze aversion

Both groups produced significantly more gaze aversions in the unwilling than unable conditions in all three tasks (Figure 2).

Affective behaviors

The 6-month-olds showed more negative affect during the unwilling than unable Mock and Play tasks. At 9 months, the difference was significant for Mock only. At 6 months, infants showed more positive affect during the unable than unwilling Block and Mock tasks. For the 9-month-olds, the difference was significant only during the Block task (Figure 3).

Discussion

This research showed that infants at 6 and 9 months discriminated between unwilling and unable partners, and responded in socially appropriate ways. Although we largely replicated the Behne et al. (2005) results at 9-months, the 6-months results differed. This is likely due to the behavioral measures we incorporated. Consistent with our hypotheses, 6- and 9-month-olds showed more negative affect and gaze aversions during the unwilling conditions, but more positive affect and reaches during the unable conditions. Our interpretation is that these findings reveal that infants were frustrated at the experimenter's unwillingness to share, but that they understood that the experimenter was trying, but unable to cooperate.

The finding that affective measures were stronger for younger infants, who showed significant discrimination in two of the three tasks, compared to significant discrimination in only one task for the older infants, may be related to an increase in agency (Leslie, 1984). According to Izard (1978), when infants become more independent, they decrease affective behavior (e.g., crying when getting a needle) and increase physical actions (such as actively resisting). This is consistent with the finding that only the 9-month-olds showed significant discrimination between conditions in terms of banging. These changes point to the importance of studying infant socio-cognitive abilities not only over time, but also in paradigms that capture a broad range of infant social behaviors (Hsu, & Fogel, 2003).

As expected, infants reached more in the unable condition. This suggests that these reaches were instrumental, as infants tried to use E as an agent to achieve their goal. This interpretation implies that infants were *aware* that the adult was trying but for some reason unable to share the toy. Behne et al., (2005) found more reaches in the unwilling condition. It has been shown that infants increase the use of more conventional communication (gestures and words) with age (Hardy, 1982), directed at changing the behavior of an unwilling adult (Mosier & Rogoff, 1994). This would predict an increase in reaching in the unwilling condition, at least in older children, as was found in Behne et al. However, both types of reaches suggest an awareness of object-directed goals in others, because both aim to elicit the adult's assistance. Therefore, this area merits further study.

That 6-month-old infants in an interactive paradigm understood the reason why they did not receive a toy, is supported by Hamlin, Hallinan & Woodward (2008), where 7-month-olds reproduced an actor's unfulfilled goal in an imitative game, but contrasts with Brandon & Wellman (2009), where only 12-month-olds inferred the goal of unsuccessful actions. In that study, infants were tested in a looking paradigm. It is possible that such a paradigm demands

more information processing than one in which infants actively participate in a give-and-take task (Legerstee, 2005). As pointed out by Mosier & Rogoff (1994, p. 78), “Social interaction may be a fertile ground for children's developing intentionality as they take a more active role to use caregivers as tools to achieve goals”.

Despite the convergence between the findings of the present study and those of Hamlin, et al. (2008), alternative explanations must be considered. For instance, Brandone and Wellman (2009) have discussed limitations of this type of paradigm, in that it does not test infants' attribution of goals, but rather, a distinction between failed actions. If infants were just looking at the surface behavior and the failure of the toy to arrive in their hands, why would they show different and *appropriate* reactions in each condition? Moreover, in two of the three unwilling conditions, there are no failed actions: E plays with the toy selfishly in each. It could further be argued that infants' discrimination is based on differential amounts of stimulation in the tasks. However, within matched pairs of conditions, the toy's position relative to the infant, the toy's direction of movement, visual and auditory stimulation, and E's physical and visual behaviour were closely matched. Finally, one might suggest that infants were able to predict whether they were likely to receive the toy based on previous experience (e.g., with people withdrawing versus dropping objects). For this type of argument to succeed, a different explanation is required to explain each instance, because the three tasks differed in several ways. Given the convergence found not only across the three tasks, but also between age groups, and across behavioral measures, a more parsimonious explanation is that infants' appropriate social behaviours were in response to the one commonality throughout: E's unwillingness versus inability to share the toy.

References

- Barna, J. & Legerstee, M. (2005). Nine and twelve-month-old infants relate emotions to people's actions. *Cognition and Emotions, 19*, 53-67.
- Behne, T., Carpenter, M., Call, J., & Tomasello, M. (2005). Unwilling versus unable: Infants' understanding of intentional action. *Developmental Psychology, 41*, 328-337.
- Brandone, A. & Wellman, H. M. (2009). You can't always get what you want: Infants understand failed goal-directed actions. *Psychological Science, 20*, 85-91.
- Bruner, J., Roy, C., & Ratner, N. (1982). The beginnings of request. In K. E. Nelson (Ed.), *Children's language* (Vol. 3, pp. 91-138). New York: Gardner.
- Crais, E., Douglas, D. D., & Campbell, C. C. (2004). The intersection of the development of gestures and intentionality. *Journal of Speech, Language, and Hearing Research, 47*, 678-694.
- Hamlin, J. K., Newman, G. E., & Wynn, K. (*in press*). Eight-month-old infants infer unfulfilled goals, despite ambiguous physical evidence. *Infancy*.
- Hamlin, J. K., Hallinan, E. V., & Woodward, A. L. (2008). Do as I do: 7-month-old infants selectively reproduce others' goals. *Developmental Science, 11*, 487-494.
- Harding, C. G. (1982). Acting with intention: A framework for examining the development of the intention to communicate. In L. Feagan, C. Garvey, & R. Golinkoff (Eds.), *The origins and growth of communication* (pp. 123-135). New York: Albex.
- Hsu, H. C., & Fogel, A. (2003). Stability and transitions in mother-infant face-to-face communication during the first 6 months: A micro-historical approach. *Developmental Psychology, 39*, 1061-1082.
- Izard, C. E. (1978). Emotions as motivations: An evolutionary-developmental perspective. *Nebraska Symposium on Motivation, 26*, 163-200.

- Legerstee, M. (2005). Triadic Interactions; Joint engagement in 5 and 7 month-olds. In *Infants' sense of people: Precursors to a Theory of Mind* (pp. 111-129). Cambridge University Press.
- Legerstee, M. (1991). The role of person and object in eliciting early imitation, *Journal of Experimental Child Psychology*, *51*, 423-433.
- Legerstee, M., Barna, J. & Di Adamo, C. (2000). Precursors to the development of intention: Understanding people and their actions at 6-months. *Developmental Psychology*, *36*, 627-634.
- Legerstee, M., Ellenbogen, B., Nienhuis, T & Marsh, H.L.. (in press). Social Bonds, Triadic Relationships and Goals: Preconditions for the Emergence of Human Jealousy
In S. Hart & M. Legerstee (Eds.). *Handbook of Jealousy: Theories, Principles and Multidisciplinary Approaches*, Wiley-Blackwell, Oxford, UK.
- Legerstee, M. & Markova, G. (2008). Variations in imitation: Ten-month-old infant awareness of intentional action. *Infant Behavior and Development*, *31*, 81-91.
- Legerstee, M. & Varghese, J. M. (2001). The role of maternal affect mirroring on social expectancies in 3-month-old infants. *Child Development*, *5*, 1301-1313.
- Leslie, A. M. (1984). Spatiotemporal continuity and the perception of causality in infants. *Perception*, *13*, 287-305.
- Markova, G. & Legerstee, M. (2006). Contingency, Imitation or Affect sharing? Foundations of Infants' social awareness. *Developmental Psychology*, *42*, 132-141.
- Mosier, C. E. & Rogoff, B. (1994). Infants' instrumental use of their mothers to achieve their goals. *Child Development*, *65*, 70-79.
- Meltzoff, A. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology*, *31*, 1-16.

- Phillips, A. T., Wellman, H. M., & Spelke, E. S. (2002). Infants' ability to connect gaze and emotional expression to intentional action. *Cognition*, *85*, 53–78.
- Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *Journal of the American Academy of Child Psychiatry*, *17*, 1-13.
- Wellman, H. M., (1990) The child's theory of Mind. London: MIT Press
- Wolff, P. H. (1966). The causes, controls, and organization of behavior in the neonate. *Psychological Issues*, *5*, Monograph No. 17.
- Woodward, A. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition*, *69*, 1-34.

Table 1

Description of perceptual matching between unwilling and unable conditions

Group	Condition	Description	Movement of toy (for both conditions)	Gaze of E (for both conditions)
Block	Unwilling	E plays with the toy selfishly on her side of the plexiglass, and doesn't try to pass it through the hole	Toy moves back and forth between E and the plexiglass	Focussed on the toy
	Unable	E tries to pass the toy to I, but can't fit it through the hole		
Mock	Unwilling	E holds toy toward I, but pulls back when I reaches	Toy moves back and forth between E and I	Alternates between toy and I
	Unable	E tries to pass toy to I, but drops it and it rolls back to E		
Play	Unwilling	E plays with toy selfishly, and won't share or engage with I	Toy stays in E's hands on her side of the table	Gazes at toy
	Unable	E repeatedly and exaggeratedly tries to operate the toy (e.g. turns key or presses button), but the toy won't work		

Note: *E=Experimenter, I=Infant*

Table 2

Results of Wilcoxon Signed-Ranks tests comparing unwilling and unable conditions for 6- and 9-month-olds.

Measure Age group	Block		Mock		Play	
	<i>Z</i>	<i>p</i>	<i>Z</i>	<i>p</i>	<i>Z</i>	<i>p</i>
Reaching						
6 months	2.51	.012*	3.38	.001***	1.33	.183
9 months	2.54	.011*	3.12	.002**	1.93	.053
Banging						
6 months	0.71	.475	0.08	.937	1.63	.103
9 months	0.91	.361	3.15	.002**	0.70	.482
Gaze Aversion						
6 months	2.41	.016*	3.41	.001***	3.08	.002**
9 months	2.99	.003**	3.19	.001***	2.55	.011*
Negative Affect						
6 months	0.81	.418	2.68	.007**	2.05	.040*
9 months	1.70	.088	3.26	.001***	0.32	.752
Positive Affect						
6 months	1.96	.050*	2.32	.021*	1.27	.204
9 months	2.67	.008**	1.15	.249	0.84	.400

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

Figure Captions

Figure 1. Mean duration of reaching (top) and mean frequency of banging (bottom) for 6-month-olds (left) and 9-month-olds (right). The asterisks denote significant differences between unwilling and unable conditions at an alpha level of 0.05. Error bars depict standard error.

Figure 2. Mean duration of gaze aversions for 6-month-olds (left) and 9-month-olds (right). The asterisks denote significant differences between unwilling and unable conditions at an alpha level of 0.05. Error bars depict standard error.

Figure 3. Mean duration of negative affect (top) and positive affect (bottom) for 6-month-olds (left) and 9-month-olds (right). The asterisks denote significant differences between unwilling and unable conditions at an alpha level of 0.05. Error bars depict standard error.

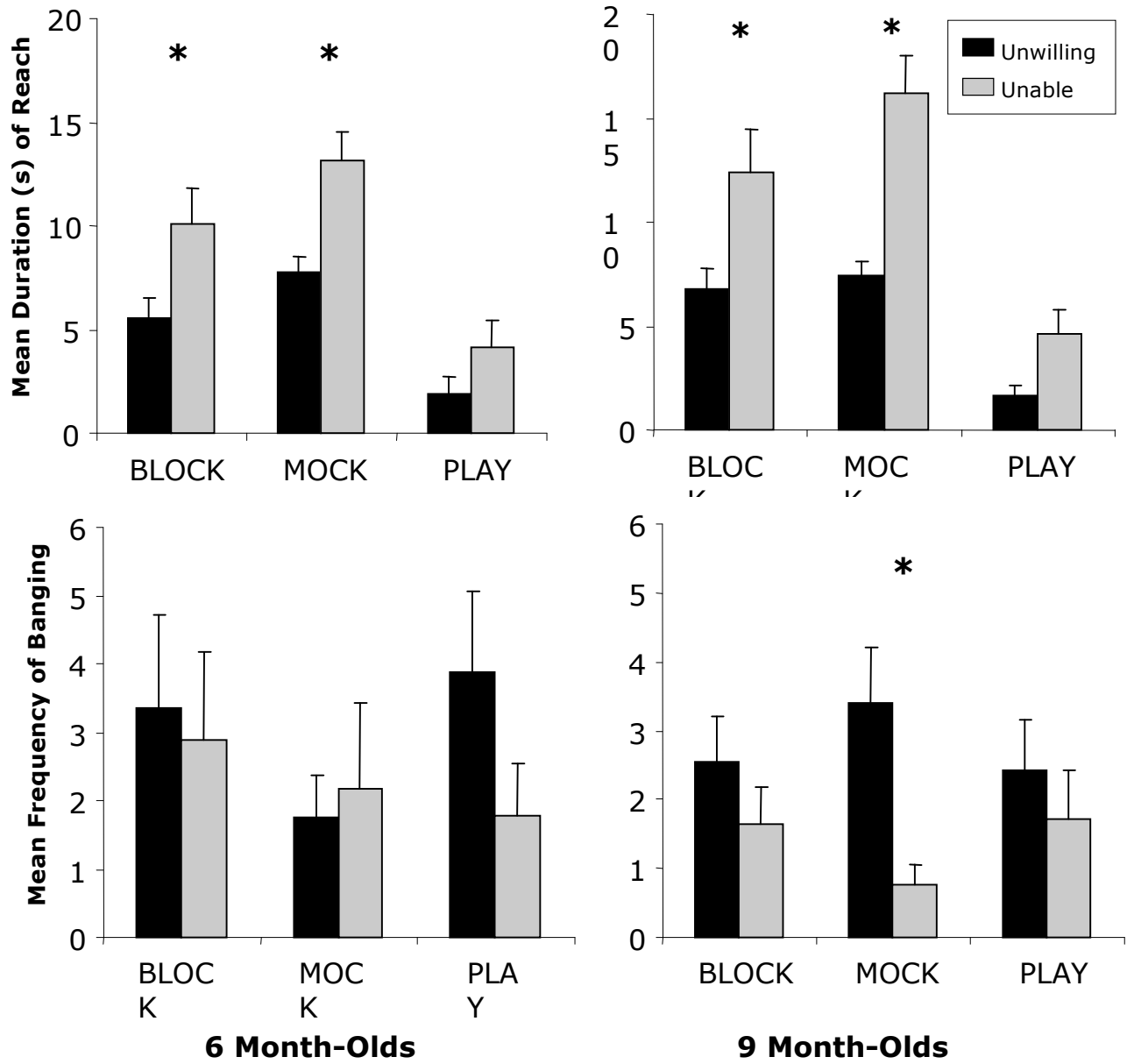


Figure 1

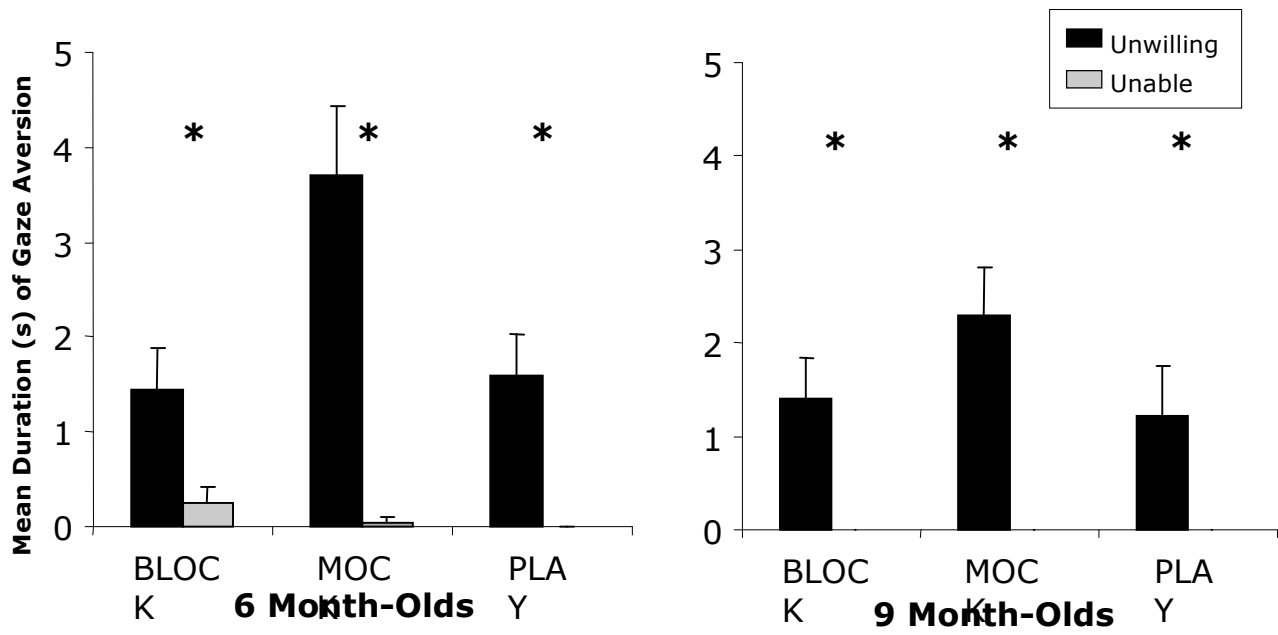


Figure 2

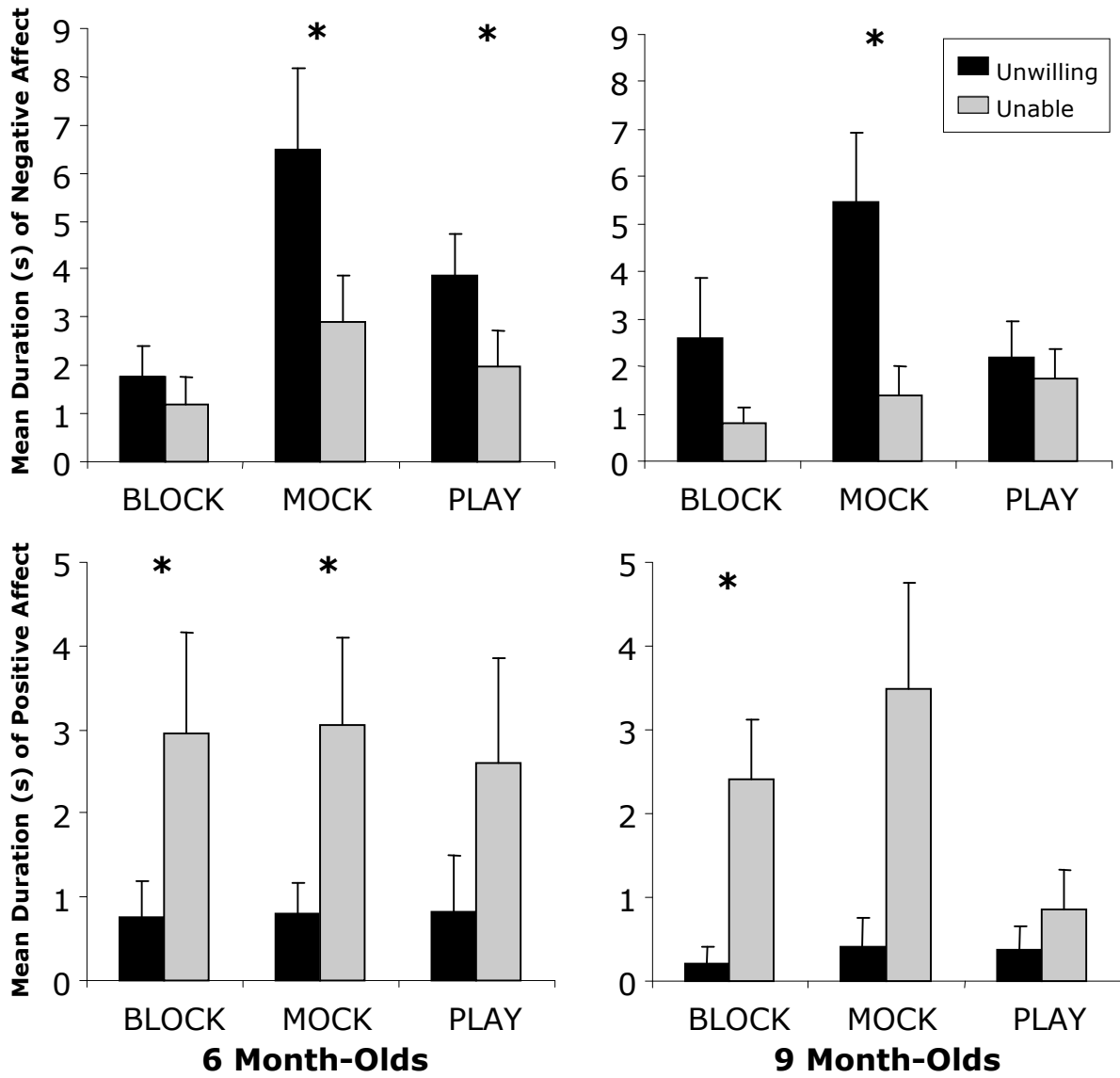


Figure 3