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The role of perceptual access in infants' third party evaluations of imitation

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Abstract

Previous research has demonstrated that preverbal infants have a preference for individuals who imitate their social partners over those who do not. It is unknown, however, if this preference is dependent upon infants' inference that the imitation reflected an intentional response to the imitator's social partner. The current experiment addresses this question by asking if infants only prefer individuals who copy their social partner to those who do not when these responding individuals had perceptual access to the partner's initial behavior. Consistent with this hypothesis, infants were more likely to reach for an imitator than a non-imitator when both had perceptual access to the movements of the social partner to whom they were responding, whereas preferential reaching to the imitator over the non-imitator did not differ from chance when the responders' access to the partner's initial behavior was blocked. However, the likelihood of reaching to the imitator did not reliably differ between the two conditions, so the experiment fell short of providing strong evidence that the imitator's perceptual access to its social partner affects the elicitation of infants' preferences. We discuss reasons for this potential weakness and ways to remedy it in future experiments.

Introduction

Humans' appreciation of imitation as a social behavior emerges early in development. One-year-old infants notice and respond positively when they are imitated by their social partners (Meltzoff, 1990; Agnetta & Rochat, 2004; Carpenter et al., 2013). At one year of age (and sometimes before), infants also imitate gestures, sounds, and instrumental actions, with social interaction and ingroup social partners eliciting more frequent copying (e.g. Barr, Dowden & Hayne, 1996; Jones, 2007; Kuhl & Meltzoff, 1996; Meltzoff & Moore, 1992; Howard, Henderson, Carrazza & Woodward, 2015; Buttelmann et al., 2013). These findings add to the picture of rapidly developing social skills that characterizes early human social development, but they also leave unanswered many questions about how and why infants (and children or adults) extract social meaning from imitation.

Two recent sets of experiments sought to explore infants' social understanding of imitation by testing what inferences and evaluations infants make on the basis of third party observations of others' imitative interactions, as well as how those inferences and evaluations are affected by individuals' roles within the imitative interaction (Powell & Spelke, in press; Powell & Spelke, 2017). Both studies presented infants with a central character who engaged in imitative interactions with one social partner and non-imitative interactions with a second social partner. Separate conditions within the studies varied whether the central character initiated each of the interactions, and was subsequently imitated by one partner and not the other, or played the responding role in each of the interactions, imitating one partner and not the other.

Following their observation of these interactions, one set of studies asked if infants drew any inferences about social affiliation between the central character and its interaction partners, using looking time to events in which the characters approached one another as a measure of infants' affiliative expectations (as in Kuhlmeier, Wynn & Bloom, 2003; Hamlin, Wynn & Bloom, 2007). Across five experiments, infants reliably differentiated events in which responding characters approached those they had vs. had not imitated. Twelve-month-old infants exhibited a strong expectation that the central character would approach social partners it had imitated rather than those it had not, with violations of this expectation drawing longer looking times. Four-month-old infants showed a similar expectation in the context of simplified events. In contrast, we found no evidence that young infants expect the initiators of interactions to affiliate with the social partners by whom they were imitated over those by whom they were not (Powell & Spelke, in press).

In the second set of studies, the imitative and non-imitative interactions were followed by preference tests that pitted the central character's two social partners against one another. When the two social partners had played the responding role in their interactions with the central character, one imitating and one responding with a contrasting action, 4-month-old infants subsequently preferred to look at the imitator over the non-imitator. In contrast, when the two social partners each initiated interactions with the central character, who imitated one partner and not the other, same age infants showed no greater interest in the imitated character than in the non-imitated character. A follow-up experiment with 12-month-old infants found that older infants also preferentially approach and reach for an imitator over a non-imitator (Powell & Spelke, 2017).

The results of these experiments cannot be easily explained by general factors that might influence infants' expectations or preferences, including the perceived similarity of the social characters to one another, the relative familiarity of one character over another, or characters' mere association with a positive social interaction. Infants' selective expectation that imitators will approach the social partners they imitated cannot be a product of infants' recognition or categorization of the imitator and imitated individual as similar to one another, because such grouping should have produced a symmetrical expectation of approach by the imitated individual toward the imitator. Familiarity can elicit preferences in infancy (e.g. bar-Haim et al., 2006; Soley & Hannon, 2010; Mehr, Song & Spelke, 2016), but cannot account for infants' selective preference for the imitator: In conditions with two responding characters, the imitator's behavior was repeated more frequently than the non-imitator's over the course of an experiment, but this frequency gap also distinguished the behavior of the target of imitation from the non-target, and infants displayed no sign of a preference for the target over the non-target in those conditions. Finally, infants did not simply prefer characters who had participated in a successful or positive social interaction, or expect them to engage with one another again, as this would have produced symmetrical expectations of approach and/or a common preference for both the imitator and the target.

Instead, these experiments suggest that infants recognize imitation, track the distinct roles of the initiating and responding parties, and perceive social meaning in acts of imitation, even when they themselves are not the target of these acts. Indeed, third party recognition of imitation, observed in these studies at 4 months of age, may precede robust first party recognition. Several studies have failed to find positive responses to being

imitated in younger infants (Agnetta & Rochat, 2004; Meltzoff, 1990; though see Nagy & Molnar, 2004), who are likely still learning to solve the correspondence problem of matching observed actions to executed ones (Cook, Bird, Catmur, Press & Heyes, 2014).

How do these studies suggest we should characterize the social meaning of imitation for young infants? The predominant explanation for older children's and adults' positive responses to imitation, which have primarily been studied with experiments in which the participants themselves are the targets of imitation, makes reference to people's preference for those who are similar to themselves ("homophily"; Byrne & Griffit, 1966; Fawcett & Markson, 2010; Mahajan & Wynn, 2012). This theory holds that when an imitator matches the posture, gestures, language or other behavior of their social partner, this leads the social partner to perceive the imitator as more similar and like them more (Chartrand & Bargh, 1999; Lakin, Jefferis, Cheng & Chartrand, 2003; Uzgiris, 1981; Haun & Over, 2015). Homophily, however, is not a good explanation for the expectations and preferences elicited in the third party experiments described above. If infants infer affiliation between similar others, they should have expected the target of imitation to approach the imitator; instead, their expectations of approach were asymmetrical and restricted to events in which the imitator approached the target (Powell & Spelke, in press). Homophily also cannot account for infants' third party preference for the imitator, as infants did not, and could not, produce the sounds and movements that characterized the imitative interactions, and were thus no more similar themselves to the imitator than to the non-imitator (Powell & Spelke, 2017).

An alternative hypothesis is that infants perceive imitation as indicative of the imitator's capacity and motivation to be a good social partner. Imitation provides strong

evidence of an imitator's attention to their social partner as, in the absence of contextual factors that would promote common behavior, attention is a necessary precursor to reliably reproducing others' actions. The same social attention is a prerequisite for interaction and communication. Imitation also provides evidence of the imitator's ability and willingness to adjust their actions, and the goals or intentions underlying those actions, to align with those of their social partner. This alignment is a prerequisite for many helpful and cooperative behaviors. Indeed, most of the helping behaviors that have been shown to elicit preferences from young infants involve the helper producing actions very similar to those of the protagonist she is attempting to help (e.g. Hamlin et al., 2007; Hamlin, Wynn & Bloom, 2010; Hamlin & Wynn, 2011). Thus, infants' expectation that imitators will affiliate with the targets of their imitation may reflect their perception that imitators have attended to their targets, aligned their behavior with that of their targets, and/or signaled their attention and behavioral alignment to their targets by producing the overt imitative acts. And infants' preference for imitators may reflect an interest in affiliating such with capable and motivated social partners themselves.

This proposal raises the possibility that infants' preference for imitators may be affected by their understanding of how the imitative behavior occurred and what other mental states or motivations it was associated with. In particular, if infants' evaluations of imitators reflect a preference for attentive and adaptive social partners, then infants may specifically prefer those who intentionally imitate others' behavior, rather than those who coincidentally or accidentally reproduce what others have done. Note that, like third party preferences themselves, this prediction dissociates the "attentive and prosocial partner"

account of infants' imitator preferences from a homophily account, in which independent similarity is an acceptable basis for liking.

One initial approach to testing this hypothesis is to ask whether infants' preferences are affected by a social character's ability to perceive the action they copied when it was initially executed by the target or model, as awareness of an action is a necessary component for its intentional reproduction. Past work provides evidence that infants can attribute perception and awareness to others (e.g. Luo & Baillargeon, 2007; Kovács, Téglás & Endress, 2010). Moreover, older infants have demonstrated the ability to integrate these attributions with their evaluations of helpful behaviors (Hamlin, Ullman, Tenenbaum, Goodman & Baker, 2013). It is thus plausible that 12-month-old infants will only positively evaluate "imitators" who have awareness of the previous behavior they reproduce. The experiment below tests this hypothesis.

Twelve- and 13-month-old infants were shown pairwise interactions between three animated characters, including an initiator, who either jumped or slid, and two responders, one who repeated the initiator's action and one who performed the alternative action. In addition, we manipulated whether the responders had perceptual access to the initiator's movements prior to responding. Participants in both conditions were then given the chance to reach for physical copies of either the imitating or non-imitating character. If infants do attribute perceptions and intentions to the characters involved in the displays, and if the inference that the imitator *intentionally* repeated the initiator's behavior is critical to infants' preference for the imitator, then we should replicate infants' preference for the imitator when perceptual access was maintained but find no preference for a "coincidental" imitator whose perceptual access to the initiator's movements was blocked.

Methods

Participants were sixty-four 11.5- to 13.5-month-old infants (26 female) recruited from the greater Boston area. Informed consent was obtained from their parents in accordance with guidelines approved by the Harvard University Committee on the Use of Human Subjects.

The experiment consisted of two phases: interaction events and a preference test. The interaction events were presented via an animated display featuring red, blue, and purple circles with faces on a green background. In each event, the center character (the ‘initiator’) first engaged in an action, and then one of the two side characters (the ‘responders’) responded by engaging in the same or a different action. However, all events also involved temporary disruptions of the responders’ perceptual access to the initiator. Each event began with a knocking sound, followed by two square occluders descending from the top of the screen to cover the responders, who were located in the top two corners of the screen (Figure 1a). In the “perceptual access” condition, the occluders rose again after a 1 s pause, moving offscreen before the initiator engaged in its action (Figure 1b). In the “no perceptual access” condition, the occluders remained over the responders while the initiator acted, and then rose immediately afterward, before the responder’s own action (Figure 1c).

The actions in these events consisted of either three vertical “jumping” movements or three horizontal “sliding” movements. The initiation of each jump or slide was accompanied by a sound that was common to all actions, and thus did not differentiate whether any given character was jumping or sliding. The movement performed by the initiator (jumping or sliding) was counterbalanced across participants, as was the identity

Figure 1. Scenes from the interaction displays for the perceptual access and no perceptual access conditions.

of the side characters who imitated this action vs. performed the contrasting action.

Participation in the six events alternated between the two responders, with the nature of the first interaction (imitative or non-imitative) also counterbalanced across participants.

A preferential reaching test was subsequently administered by a display-blind experimenter. She brought out physical copies of the two responding characters (i.e. the imitator and non-imitator), held them up out of the infant's reach and attracted the infant's gaze to a central location, asked "Who do you like?", and then moved the figures forward toward the infant. Choice was coded as the character first targeted by a visually guided reaching and grasping action. If an infant attempted to reach for both figures at once, or reached for one figure without also visually fixating it, the experimenter pulled the figures back, recentered the infant's gaze and then moved the figures forward again, slightly farther apart to prevent simultaneous reaching to both. If an infant did not attempt to reach within 30 s of presentation, the experimenter pulled the figures back, made eye

contact with the infant and again asked “Who do you like?”, and then moved the figures forward again. Infants who failed to make a visually guided reach to a single character after three presentations were excluded from the sample and replaced.

The display-blind experimenter recorded her judgment of the character to whom the first visually guided reach was directed, and these judgments constituted the data over which analyses were performed. An additional condition- and display-blind coder made similar judgments offline from video of 25% of the sessions, and agreement between the coders was 100%.

Results and Discussion

In the *perceptual access* condition, more than twice as many infants reached for the imitator as for the non-imitator (22/32), although the difference was right at the cusp of the threshold for statistical significance (binomial probability test: $P = 0.050$). In the *no perceptual access* condition, the proportion of infants who reached for the imitator did not differ significantly from chance (18/32, binomial probability test: $P > 0.5$). The difference in reaching patterns across the two conditions did not approach significance (Fisher’s exact test: $P > 0.4$).

These results are consistent with the prediction that we would observe evidence of an imitator preference only when it was plausible that the imitator’s matching of the central character’s behavior was intentional. However, the lack of a significant difference between the two conditions precludes us from concluding that responders’ perceptual access impacts infants’ preference for those who imitate, and it raises the question why the findings were so weak. One potential source of statistical weakness is an underpowered sample size. After doubling the sample size per condition relative to our previous test of

Figure 2. Frequency of target character for infants' first, visually guided reach in each condition.

preferential reaching (Powell & Spelke, 2017), we were not underpowered to detect a preference of a similar magnitude (13/16), or even slightly weaker, within a single condition, employing a binomial test with a standard two-tailed alpha value of 0.05.¹ (And we were, indeed, able to detect an imitator preference in the perceptual access condition.) However, when trying to detect a difference in single trial reaching preferences between two conditions, an N of 32 participants per condition only provides sufficient power if the difference is very large (i.e. if infants have a preference for one character in one condition and the other character in the other condition [Hamlin, Wynn, Bloom & Mahajan, 2011; Hamlin, Mahajan, Liberman & Wynn, 2013]). In order to have a suitable probability of differentiating chance reaching in one condition and a moderately strong preference for the imitator (e.g. 75% of infants) in the other condition, we would have needed to double the

¹For a binomial test comparing a population in which the true proportion of infants preferring the imitator is 0.81 (i.e. 13/16) to the chance level of 0.5, an N of 20 is required to achieve 80% power. If the true population preference is only 0.75, the necessary N rises to 30. These and all other power calculations performed using G*Power.

sample size again, to an N of 64 *per condition*. Follow up studies should either address this question with an appropriate sample size, or with a more sensitive measure that provides higher power for detecting weak preferences and smaller between-group differences.

There is no strong evidence that the proportion of infants reaching for the imitator in the current perceptual access condition (22/32, 69%) reliably differed from that in our previous research (13/16, 81%; Fisher's exact test, $P > 0.4$). However, for the sake of optimizing future experiments, it is worth considering whether any features of the current experiment may have in fact weakened infants' preference for imitators relative to non-imitators. One major difference between the perceptual access condition described above and past studies assessing infants' third party preferences for imitators using preferential looking and reaching measures is that, in the current case, the imitator and non-imitator go through brief periods of total occlusion. An actor's full occlusion or absence has been used in the past to manipulate infants' impression of the actor's perceptual access to information (e.g. Kovács et al., 2010; Hamlin, Ullman et al., 2013; Onishi & Baillargeon, 2005; Surian & Geraci, 2012). However, a closer examination of this research reveals that infants at or below the age of the current participants (i.e. 13 months and younger) may have difficulty maintaining information about both the actor's awareness and her goals through periods of full occlusion. Surian and Geraci (2012), for example, found that a chaser's brief exit from the screen disrupted 11-month-old (but not 17-month-old) infants' anticipation of the chaser's path, even in "true belief" trials when this absence had no consequences for the accuracy of the chaser's beliefs about the chasee's location. Similarly, Sodian and Thoermer (2008) observed that an actor's temporary occlusion by a screen disrupted 16-month-old infants' expectation that she would reach into a box with a toy rather than an empty box,

even if, following the occlusion event, the actor was continuously present and attentive while the toy moved into the box prior to her reach.

In contrast, studies in which infants 13 months of age or younger appear to respond appropriately to manipulations of perceptual access have often not required infants to track and integrate the knowledge and goals of an actor who undergoes absence or full occlusion. Hamlin, Ullman and colleagues (2013) contrasted preferences between ignorant helper and hinderers, who were absent during a demonstration of the protagonist's goal, with preferences for knowledgeable helper and hinderers who were present throughout the experiment and thus did not need to be tracked across a period of occlusion. Kovács and colleagues (2010) tested the impact of a character's absence during an object transfer on 7-month-old infants' own representations of the object's location, but success did not require the infants to predict or interpret intentional behavior on the part of the character. Finally, Luo and Baillargeon (2007) did observe that 12.5-month-old infants can successfully integrate an actor's perceptual access, or lack thereof, to multiple objects with observations of her reaching behavior in order to infer the actor's object preferences, but this study manipulated perceptual access by using clear or obliquely oriented opaque walls that separated the actor from its goal object while leaving both the actor and the object visible, rather than the temporary occlusion or absence of the actor. There are also a number of demonstrations that infants at and above 18 months of age can maintain information about an actor's goal during the actor's absence and integrate this goal with an understanding of the actor's knowledge or ignorance of current circumstances following that absence to generate an appropriate action prediction (e.g. Surian & Geraci, 2012; Buttelmann, Carpenter & Tomasello, 2009; Knudsen & Liszkowski, 2012). Thus, future

experiments should perhaps either test somewhat older infants or find an alternative means of conveying responders' lack of perceptual access to the initiator's actions.

In addition to factors that could have attenuated an imitator preference in the perceptual access condition, it is also possible that unintended factors of our study design enhanced reaching for the imitator in the no perceptual access condition. For example, the outcome measure—selective reaching—is known to be influenced not only by infants' social preferences but by their curiosity and motivation to explore objects whose behavior they failed to predict (Sim & Xu, 2017). Although the perceptual access condition may have engendered a social preference for the imitator, the no-perceptual access condition may have engendered interest in that character, whose ability to copy an unseen action was neither predicted nor expected.

Finally, it is possible that infants' understanding of imitation and preference for imitators does not depend on evidence that imitators have observed the acts that they copy, when the targets of imitation emit sounds. Throughout their 12 months of experience as social partners and observers, infants have seen people talk to others through closed doors, in different rooms, or over the telephone. They expect such talk to convey information about the speaker's actions and goals, when those actions were not seen by the addressee (Martin, Onishi & Vouloumanos, 2012). Thus, infants likely do not view perceptual access as a necessary condition for awareness, by one party to a social interaction, of the other party's behavior, if the parties communicate vocally. Because all the characters in the present studies jumped and made sounds during their actions, infants may have interpreted the sounds as conveying information about the actions, therefore

attributing awareness of the target's action to the imitator in both conditions. Future research, using other displays and methods, could test each of these possibilities.

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References

- Agnetta, B., & Rochat, P. (2004). Imitative games by 9-, 14-, and 18-month-old infants. *Infancy, 6*, 1–36.
- bar-Haim, Y., Ziv, T., Lamy, D., & Hodes, R. M. (2006). Nature and nurture in own-race face processing. *Psychological Science, 17*, 159–163.
- Barr, R., Dowden, A., & Hayne, H. (1996). Developmental changes in deferred imitation by 6-to 24-month-old infants. *Infant Behavior and Development, 19*, 159–170.
- Buttelmann, D., Carpenter, M., & Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition, 112*(2), 337–342.
- Buttelmann, D., Zmyj, N., Daum, M., & Carpenter, M. (2013). Selective imitation of in-group over out-group members in 14-month-old infants. *Child Development, 84*, 422–428.
- Byrne, D., & Griffitt, W. (1966). A developmental investigation of the law of attraction. *Journal of Personality and Social Psychology, 4*, 699–702.
- Carpenter, M., Uebel, J., & Tomasello, M. (2013). Being mimicked increases prosocial behavior in 18-month-old infants. *Child Development, 84*, 1511–1518.

- Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: the perception–behavior link and social interaction. *Journal of Personality and Social Psychology*, 76, 893–910.
- Cook, R., Bird, G., Catmur, C., Press, C., & Heyes, C. (2014). Mirror neurons: from origin to function. *Behavioral and Brain Sciences*, 37, 177-192.
- Fawcett, C. A., & Markson, L. (2010). Similarity predicts liking in 3-year-old children. *Journal of Experimental Child Psychology*, 105, 345-358.
- Hamlin, J. K., Mahajan, N., Liberman, Z., & Wynn, K. (2013). Not like me= bad: Infants prefer those who harm dissimilar others. *Psychological Science*, 24, 589-594.
- Hamlin, J. K., Ullman, T., Tenenbaum, J., Goodman, N., & Baker, C. (2013). The mentalistic basis of core social cognition: experiments in preverbal infants and a computational model. *Developmental Science*, 16(2), 209-226.
- Hamlin, J. K., & Wynn, K. (2011). Young infants prefer prosocial to antisocial others. *Cognitive Development*, 26, 30–39.
- Hamlin, J. K., Wynn, K., & Bloom, P. (2007). Social evaluation by preverbal infants. *Nature*, 450, 557–559.
- Hamlin, K. J., Wynn, K., & Bloom, P. (2010). Three-month-olds show a negativity bias in their social evaluations. *Developmental Science*, 13, 923-929.
- Hamlin, J. K., Wynn, K., Bloom, P., & Mahajan, N. (2011). How infants and toddlers react to antisocial others. *Proceedings of the National Academy of Sciences*, 108, 19931-19936.
- Haun, D. B. M., & Over, H. (2015). A homophily-based account of human culture. In: Richerson, P. J., & Christiansen, M. H., eds. *Cultural evolution: society, technology, language, and religion*. Cambridge, MA: MIT Press.

- Howard, L. H., Henderson, A. M., Carrazza, C., & Woodward, A. L. (2015). Infants' and young children's imitation of linguistic in-Group and out-Group informants. *Child Development, 86*, 259-275.
- Jones, S. S. (2007). Imitation in infancy: the development of mimicry. *Psychological Science, 18*, 593-599.
- Knudsen, B., & Liszkowski, U. (2012). Eighteen-and 24-month-old infants correct others in anticipation of action mistakes. *Developmental Science, 15*(1), 113-122.
- Kovács, Á. M., Téglás, E., & Endress, A. D. (2010). The social sense: Susceptibility to others' beliefs in human infants and adults. *Science, 330*(6012), 1830-1834.
- Kuhl, P. K., & Meltzoff, A. N. (1996). Infant vocalizations in response to speech: Vocal imitation and developmental change. *The Journal of the Acoustical Society of America, 100*, 2425-2438.
- Kuhlmeier, V., Wynn, K., & Bloom, P. (2003). Attribution of dispositional states by 12-month-olds. *Psychological Science, 14*, 402-408.
- Lakin, J. L., Jefferis, V. E., Cheng, C. M., & Chartrand, T. L. (2003). The chameleon effect as social glue: Evidence for the evolutionary significance of nonconscious mimicry. *Journal of Nonverbal Behavior, 27*, 145-162.
- Luo, Y., & Baillargeon, R. (2007). Do 12.5-month-old infants consider what objects others can see when interpreting their actions?. *Cognition, 105*(3), 489-512.
- Mahajan, N., & Wynn, K. (2012). Origins of "us" versus "them": Prelinguistic infants prefer similar others. *Cognition, 124*, 227-233.
- Martin, A., Onishi, K. H., & Vouloumanos, A. (2012). Understanding the abstract role of speech in communication at 12 months. *Cognition, 123*, 50-60.

- Mehr, S. A., Song, L. A., & Spelke, E. S. (2016). For 5-month-old infants, melodies are social. *Psychological Science*, 486-501.
- Meltzoff, A. N. (1990). Foundations for developing a concept of self: the role of imitation in relating self to other and the value of social mirroring, social modeling, and self practice in infancy. In: Cicchetti, D. B. M., ed. *The self in transition: infancy to childhood*. New York: Cambridge University Press.
- Meltzoff, A. N., & Moore, M. K. (1992). Early imitation within a functional framework: The importance of person identity, movement, and development. *Infant Behavior and Development*, 15, 479-505.
- Nagy, E., & Molnar, P. (2004). Homo imitans or homo provocans? Human imprinting model of neonatal imitation. *Infant Behavior and Development*, 27, 54-63.
- Onishi, K. H., & Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs?. *Science*, 308(5719), 255-258.
- Powell, L. J., & Spelke, E. S. (in press). Human infants' understanding of social imitation: Inferences from third party observations. *Cognition*. bioRxiv doi: 10.1101/050385
- Powell, L. J., & Spelke, E. S. (2017). Third party preferences for imitators in preverbal infants. Retrieved from psyarxiv.com/2svkh
- Sim, Z. L., & Xu, F. (2017). Infants preferentially approach and explore the unexpected. *British Journal of Developmental Psychology*.
- Sodian, B., & Thoermer, C. (2008). Precursors to a theory of mind in infancy: Perspectives for research on autism. *The Quarterly Journal of Experimental Psychology*, 61(1), 27-39.

- Soley, G., & Hannon, E. E. (2010). Infants prefer the musical meter of their own culture: a cross-cultural comparison. *Developmental Psychology, 46*, 286-292.
- Surian, L., & Geraci, A. (2012). Where will the triangle look for it? Attributing false beliefs to a geometric shape at 17 months. *British Journal of Developmental Psychology, 30*, 30-44.
- Uzgiris, I. C. (1981). Two functions of imitation during infancy. *International Journal of Behavioral Development, 4*, 1-12.