UNIVERSITY OF CALIFORNIA, MERCED

Examining the interconnection between social cognition and emotion understanding

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

in

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by

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To Kate

Table of Contents

List of Figures

List of Tables

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Curriculum Vitae

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PUBLICATIONS

Reschke, P. J., Walle, E., A, Knothe, J., M., & Lopez, L. D. (in press). The influence of context on distinct facial expressions of disgust.

Reschke, P. J., Knothe, J. M., Lopez, L. D., & Walle, E. A. (2018). Putting 'context' in context: Examining the effects of body posture and emotion scene on adults' categorizations of affective facial expressions. *Emotion, 18*, 153-158.

Reschke, P. J., Walle, E. A., Flom, R., & Guenther, D. (2017). Twelve-month-old infants' sensitivity to others' emotions following positive and negative events. *Infancy*, *22*, 874-881.

Walle, E. A., **Reschke, P. J.**, Camras, L. A., & Campos, J. J. (2017). Infant differential behavioral responding to discrete emotions. *Emotion, 17,* 1078-1091.

Lopez, L. D., **Reschke, P. J.**, Knothe, J. M., & Walle, E. A. (2017). Postural communication of emotion: Validation of distinct poses for five discrete emotions. *Frontiers in Psychology*, *8*, 710.

Reschke, P. J., Walle, E. A., & Dukes, D. (2017). Interpersonal development in infancy: The interconnectedness of emotion understanding and social cognition. *Child Development Perspectives, 11*, 178-183.

Walle, E. A., **Reschke, P. J.,** & Knothe, J. M. (2017). Social referencing: Defining and delineating a basic process of emotion. *Emotion Review, 9*, 245-252.

Walle, E. A., **Reschke, P. J.,** & Knothe, J. M. (2017). Putting social referencing and social appraisal back together again. *Emotion Review, 9*, 269-270.

MANUSCRIPTS UNDER REVIEW/REVISION

Walle, E. A., **Reschke, P. J.**, Main, A., & Shannon, R. (under review). The development of distinct prosocial behaviors in infancy.

*Walle, E. A., ***Reschke, P. J.,** Lopez, L. D., & Knothe, J., M. (under revision). The additive and interactive effects of specific emotion cues on emotion categorization: Faces, postures, and scenes.

Reschke, P. J. & Walle, E. A. (under revision). Adult judges use heuristics when categorizing infants' responses to others' emotions.

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MANUSCRIPTS IN PREPARATION

Reschke, P. J., Walle, E. A., & Dukes, D. (in prep). Was that intentional? Infants use others' emotional expressions to infer their goals.

Walle, E. A., **Reschke P. J.,** Knothe, J. M., & Lopez, L. D. (in prep). Pieces of the emotion pie: A relational approach to emotion perception.

***Reschke, P. J.** & *Walle, E. A. (in prep). Infant differential responding to discrete emotions: Developmental differences in the emotion process.

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RESEARCH IN PROGRESS

Infants' understanding of others' emotions and beliefs.

Infants' expectations of prosocial, antisocial, and avoidant behaviors.

The effect of context on emotion categorizations of dynamic facial expressions.

ORGANIZED CONFERENCE SYMPOSIA

Reschke, P. J. (Chair, 2018 July). Bridging Research on Emotional Development and Social Cognition. Biennial Meeting of the International Congress on Infant Studies in Philadelphia, Pennsylvania.

Reschke, P. J. (Chair, 2017 April). The Development of Anticipating Others' Emotions Across Infancy and Childhood. Biennial Meeting of the Society for Research on Child Development in Austin, Texas.

CONFERENCE TALKS AND PRESENTATIONS

Reschke, P. J., Walle, E. A., & Dukes, D. (2018, July). Did you mean to do that? Infants use emotional communication to infer and re-enact others' intentions. Paper to be presented at the Biennial Meeting of the International Congress on Infant Studies, Philadelphia, Pennsylvania.

Shannon, R., **Reschke, P. J.,** & Walle, E. A. (2018, July). Beyond prosocial: The development of distinct forms of prosocial behavior. Poster to be presented at the Biennial Meeting of the International Congress on Infant Studies, Philadelphia, Pennsylvania.

Reschke, P. J., Walle, E. A., Lopez, L. D. & Knothe, J. M. (2018, May). The effect of context on distinct facial expressions of disgust. Poster to be presented at the Annual Convention of the Association for Psychological Science, San Francisco, California.

Reschke, P. J., Walle, E. A., & Dukes, D. (2018, May). Did you mean to do that? Infants use emotional communication to infer and re-enact others' intentions. Poster to be presented at the Annual Convention of the Association for Psychological Science, San Francisco, California.

Reschke, P. J., Walle, E. A., Lopez, L. D. & Knothe, J. M. (2018, April). The effect of context on distinct facial expressions of disgust. Poster presented at the Annual Conference of the Society for Affective Science Los Angeles, California.

Reschke, P. J., Walle, E. A., & Dukes, D. (2018, April). Did you mean to do that? Infants use emotional communication to infer and re-enact others' intentions. Flash Talk presented at the Annual Conference of the Society for Affective Science Los Angeles, California.

Reschke, P. J., Walle, E. A., & Dukes, D. (2017, August). Was that intentional? Infants use others' emotional expressions to infer their goals. Paper presented at the European Conference on Developmental Psychology, Utrecht, Netherlands.

Dukes, D., **Reschke, P. J.,** & Walle, E. A. (2017, August). Recognizing the connection between emotion understanding and social cognition in infant development. Poster presented at the European Conference on Developmental Psychology, Utrecht, Netherlands.

Reschke, P. J., Walle, E. A., Knothe, J. M., & Lopez, L. D. (2017, July). Putting 'context' in context: The effects of body posture and emotion scene on adult categorization of disgust facial expressions. Paper presented at the International Society for Research on Emotion Conference, St. Louis, Missouri.

Lopez, L. D., **Reschke, P. J.,** Knothe, J. M., & Walle, E. A. (2017, July). Postural communication of emotion: Validation of distinct poses for five discrete emotions. Poster presented at the International Society for Research on Emotion Conference, St. Louis, Missouri.

Reschke, P. J., Walle, E. A, & Flom, R. (2017, April). Twelve-month-old infants' expectations of what elicits others' emotions. Paper presented at the Biennial Meeting of the Society for Research on Child Development, Austin, Texas.

Walle, E. A., **Reschke, P. J.,** Camras, L. A., Campos, J. J. (2017, April). The development of infant differential behavioral responding to discrete emotions. Paper symposium presented at the Biennial Meeting of the Society for Research on Child Development, Austin, Texas.

Reschke, P. J., Walle, E. A, & Flom, R. (2016, May). The development of infant expectations of emotional outcomes. Poster presented at the Biennial Meeting of the International Congress on Infant Studies, New Orleans, Louisiana.

Walle, E. A., Campos, J. J., Lopez, L., Johal, J., **Reschke, P. J.,** & Knothe, J. M. (2016, May). Crawling and walking infants' gaze following: Relations with parent-infant joint engagement. Paper presented at the Biennial Meeting of the International Congress on Infant Studies, New Orleans, Louisiana.

Reschke, P. J., Walle, E. A., & Flom, R. (2016, January). Infants’ expectations of others’ emotions following positive and negative interactions. Poster presented at the Emotion Pre-Conference at the Annual Convention of the Society for Personality and Social Psychology, San Diego, California.

Walle, E. A., **Reschke, P. J.,** Campos, J. J., & Camras, L. (2015, July). The development of infant responding to discrete emotions: Differential responses in 16- and 24-month-old infants. Paper presented at the International Society for Research on Emotion Conference, Geneva, Switzerland.

Reschke, P. J., Walle, E. A., & Flom, R. (2015, July). Infant understanding of the causes of emotions: Evidence from 12-month-olds. Poster presented at the International Society for Research on Emotion Conference, Geneva, Switzerland.

Reschke, P. J., Walle, E. A., Camras, L. A., & Campos, J. J. (2015, April). Adult recognition of infant behavioral responding to discrete emotions. Poster presented at the Biennial Meeting of the Society for Research on Child Development, Philadelphia, Pennsylvania.

Walle, E. A., Campos, J. J., & **Reschke, P. J.** (2014, July). Joint visual attention and gesturing following the onset of infant walking: Possible relations with language development. Paper presented at the International Conference on Infant Studies, Berlin, Germany.

Walle, E. A., **Reschke, P. J.,** Campos, J. J., & Camras, L. (2014, July). The development of infant differential behavioral responding to discrete emotions. Paper presented at the International Conference on Infant Studies, Berlin, Germany.

Reschke, P. J., Walle, E. A., Campos, J. J., & Camras, L. A. (2014, June). The development of infant behavioral responding to discrete emotions. Poster presented at the Biennial International Conference on Infant Studies, Berlin, Germany.

Walle, E. A., **Reschke, P. J.,** Campos, J. J., & Camras, L. (2013, August). The development of infant differential behavioral responding to discrete emotions. Paper presented at the International Society for Research on Emotion Conference, Berkeley, California.

Reschke, P. J., Walle, E. A., Campos, J. J., & Camras, L. A. (2013, March). The development of infant behavioral responding to discrete emotions. Poster presented at the Biennial Meeting of the Society for Research on Child Development in Seattle, Washington.

Sanders, P., **Reschke, P. J.,** & Reber, J. (2011, June). A relational approach to the study of music and emotion. Paper presented at the Interdisciplinary Symposium for Qualitative Research in Music and Medicine in Weber, Utah.

Reschke, P. J., Sanders, P., & Reber, J. (2011, June). A relational approach to the study of music and emotion. Poster presented at the Interdisciplinary Symposium for Qualitative Research in Music and Medicine in Weber, Utah.

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Reschke, P. J. (2017). Emotional Development. Guest lecture in Brigham Young University School of Family Life course, "Infant Development in the Family," Provo, Utah.

Reschke, P. J. (2017). Cognitive Development. Guest lecture in Brigham Young University Department of Psychology course, "Introduction to Psychology," Provo, Utah.

Reschke, P. J. (2017). The development of emotion understanding and social cognition: How infants respond to emotional communication and infer others' mental states. Invited talk at Brigham Young University School of Family Life, Provo, Utah.

Reschke, P. J. (2017). The social functions of emotion in infancy and adulthood. Invited talk at Brigham Young University Department of Psychology, Provo, Utah.

Reschke, P. J. (2017). Perceptual development. Guest lecture in UC Merced course, "Cognitive Development," Merced, California.

Reschke, P. J. (2017). Prenatal development and birth. Guest lecture in UC Merced course, "Developmental Psychology," Merced, California.

Reschke, P. J. (2017). Biological and Cultural Foundations of Development. Guest lecture in UC Merced course, "Developmental Psychology," Merced, California.

Reschke, P. J. (2017). Twelve-month-old infants' expectations of what elicits others' emotions. Talk presented at the UC Merced Psychological Sciences Colloquium Series, Merced, California.

Reschke, P. J. (2017). Was that intentional? Infants use others' emotional expressions to infer their goals. Talk presented at the 4th Annual Psychological Sciences Symposium, Merced, California.

Reschke, P. J. (2016). Infant Attachment and Temperament. Guest lecture in UC Merced course, "Introduction to Psychology," Merced, California.

Reschke, P. J. (2016). Empathy. Guest lecture in UC Merced course, “Emotion,” Merced, California.

Reschke, P. J. (2015). Infant Attachment. Guest lecture in UC Merced course, “Introduction to Psychology,” Merced, California.

Reschke, P. J. (2014). The development of infant cognition. Guest lecture in UC Merced course, “Developmental Psychology,” Merced, California.

Reschke, P. J. (2014). Prenatal development. Guest lecture in UC Merced course, “Developmental Psychology,” Merced, California.

Reschke, P. J. (2013). Explaining the increases in receptive and productive vocabulary following the onset of walking. Talk presented at the UC Merced Psychological Sciences Colloquium Series, Merced, California.

Reschke, P. J. (2012). Teratogens. Guest lecture in UC Merced course, “Developmental Psychology,” Merced, California.

Reschke, P. J. (2012). Education in early childhood. Guest lecture in UC Merced course, “Developmental Psychology,” Merced, California.

Reschke, P. J. (2012). Changes in language, gesturing, and joint-visual attention following the onset of walking. Talk presented at the UC Merced Psychological Sciences Colloquium Series, Merced, California.

CONFERENCE PROCEEDINGS

Reschke, P. J., Sanders, P., & Reber, J. S. (2012). A relational approach to the study of music and emotion. In D. Akombo & J. Ruszkowski (Eds.), The Journal of ISQRMM. Paper presented at the Interdisciplinary Society for Quantitative Research in Music and Medicine, Weber State University, Ogden, UT, 2-3 June, 2011. New York: Curran Associates Publications.

Roper, J., Reber, J. S., Sanders, P., **Reschke, P. J.,** & Cannavo, P. (2012). Music and emotion: A qualitative study. In D. Akombo & J. Ruszkowski (Eds.), The Journal of ISQRMM. Paper presented at the Interdisciplinary Society for Quantitative Research in Music and Medicine, Weber State University, Ogden, UT, 2-3 June, 2011. New York: Curran Associates Publications.

TEACHING EXPERIENCE

Instructor of Record

2017 Summer	Analysis of Psychological Data
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2017 Fall	Cognitive Development, with Rose Scott, Ph.D.
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2016 Spring	Emotion, with Eric Walle, Ph.D.
2015 Fall	Introduction to Psychology, with Meaghan Altman, Ph.D.

Teaching Assistant

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PLoS One
Social Development
Society for Personality and Social Psychology – Conference submissions

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Abstract

Understanding emotion in interpersonal contexts involves appreciating others' relations with the environment. This ability is related fundamentally to social cognition, including understanding the actions and goals of social partners. However, the significance of infants' emotion understanding has been largely underemphasized in recent studies on infants' social-cognitive development. This dissertation presents the results of three experiments investigating the interconnectedness of emotion understanding and social cognition in socioemotional development. Study 1 investigated 12-month-old infants' sensitivity to others' emotional reactions to positive and negative events. The results provide the earliest evidence that infants expect others to respond with positive emotions to positive events and negative emotions to negative events. Study 2 examined 15- and 18-month-old infants' use of an experimenter's emotional communication to disambiguate and imitate her demonstrations of failed attempts to perform target actions on novel objects. Analyses of infants' imitation of the target action indicated that 18-month-old infants, but not 15-month-olds, imitated more target actions when the experimenter expressed frustration after each failed attempt than when she expressed neutral affect. Study 3 sought to determine whether infants expect others to respond with emotions congruent with others' perception of events, even if such perceptions are mistaken. The results, however, did not support these predictions. Infants did not appear to demonstrate any clear expectations regarding others' belief-based emotional reactions to events. Taken together, the findings from these experiments advance our understanding of infant social cognitive and emotional development.

Chapter 1

Understanding emotion is inherently linked with social cognition. To understand others' emotions is to comprehend the significance of the relations of other individuals with their goals and environment (Campos, Mumme, Kermoian, & Campos, 1994; Saarni, Campos, Camras, & Witherington, 2006). Likewise, social cognition encompasses many emotion-related skills, such as understanding goal directedness (Behne, Carpenter, Call, & Tomasello, 2005), representing intentions (Brandone & Wellman, 2009; Carpenter, Akhtar, & Tomasello, 1998), and evaluating others' needs and coordinating helpful responses (see Buttelmann, Carpenter, & Tomasello, 2009; Warneken & Tomasello, 2009). Thus, it is important to consider how the processes of emotion understanding and social cognition are interrelated.

Linking Emotion Understanding and Social Cognition

Social cognition and emotion understanding both involve understanding others' goals. Yet confusion often arises when differentiating these constructs. Emotion understanding entails perceiving a significant relation between a social partner and his or her perceived environment, which may be signaled by an emotional expression (e.g., an angry face; Saarni et al., 2006) or other explicit cue (e.g., persistent and selective actions; see Hernik & Southgate, 2012; Premack & Premack, 1994), or inferred from implicit environmental cues (e.g., situational information; Gnepp, McKee, & Domanic, 1987; Thompson, 1987). In contrast, social cognition is a broader construct in that the motivational states perceived do not have to be relationally significant to the social partner. For example, one can infer goal directedness when observing someone walk out of a building, but the goal may not necessarily be significant to the individual—though it could be if the building were on fire (i.e., inferring fear). Thus, emotion understanding always involves social cognition, whereas social cognition is emotionally relevant only when *significant* goal relations are perceived.

Research on social-cognitive development can illuminate key processes inherent to the ontogeny of early emotion understanding, and vice versa. For example, infants' appreciation of others' affective expressions is likely tied to their capacity to infer others' goals (Walle & Campos, 2012), particularly when such goals are ambiguous (Carpenter et al., 1998). Consider an infant observing another individual knock over a tower of blocks. The individual's sad expression after the tower falls would indicate incongruence with her goal (i.e., the tower was knocked over accidentally), whereas a smile might indicate attainment of a goal (i.e., the tower was knocked over purposely). Identifying the emotional signal (e.g., she is happy) or the goal (e.g., she intended to topple the tower) in isolation falls short of appreciating how the two relate to the outcome (e.g., she is happy because she achieved her goal of knocking over the tower).

Below I review three areas of social cognition in which the integration of emotion has furthered our understanding of social development: action understanding, goal understanding, and false belief understanding. I also identify avenues for potential growth in each of these areas.

Infants' Understanding of Actions

Goal-directed actions are emotionally relevant insofar that the goals are relationally significant to the individual. The interconnected nature of this phenomenon makes it possible to use others' emotions to predict their actions, and vice versa. Research has demonstrated that even infants can use others' emotional communications to anticipate their actions (Barna & Legerstee, 2005; Phillips, Wellman, & Spelke, 2002; though see also Vaish & Woodward, 2010) and coordinate adaptive responses in interpersonal contexts (for a review, see Walle & Campos, 2012). In research using the emotional eavesdropping paradigm (Repacholi, Meltzoff, & Olsen, 2008; Repacholi, Meltzoff, Rowe, & Toub, 2014), 15- and 18-month-olds regulated their imitative behavior of a novel action as a function of whether that behavior had previously elicited an observer's emotional reaction (angry versus neutral) and whether the observer later watched the infant. These studies demonstrate that infants can apply knowledge of an observed negative emotional transaction to future scenarios in which the infant could become the target of a social partner's anger.

Work investigating infants' understanding of others' preferences also illustrates how infants use previously observed emotional information to engage in complex social interactions (Repacholi & Gopnik, 1997). Fourteen- and 18-month-olds observed an experimenter express positive affect after tasting one variety of food and negative affect after tasting another. Only the 18-month-olds understood the experimenter's preference and were more likely to provide her with the favored food, even when her preference differed from their own. This demonstrates that the development of infants' understanding of others' emotions plays an important role in how infants appreciate others' actions.

Infants can also use others' actions to predict their emotions. This ability likely depends on infants' appreciation of goal directedness (Brandone & Wellman, 2009; Woodward, 1998). For example, infants demonstrate an understanding of successful goals by 6 months (Woodward, 1998), but do not demonstrate an understanding of the emotional consequences of successful goals until 10 months (Skerry & Spelke, 2014). Similarly, infants show an understanding of failed goals as early as 8–10 months (Brandone & Wellman, 2009; Brandone, Horwitz, Aslin, & Wellman, 2014; Hamlin, Newman, & Wynn, 2009), but do not appear to demonstrate emotional expectations for failed goals until 14–18 months (Chiarella & Poulin-Dubois, 2013; Hepach & Westermann, 2013). In these studies, infants' ability to anticipate others' emotional outcomes was predicated on an emerging appreciation of the link between others' actions and goals. This suggests that the development of understanding others' emotions depends on the development of understanding others' goals and emerges sometime during the second year of life. However, research in this area has suffered from inconsistencies in which emotions were used and how this ability was indexed. For example, Skerry and Spelke (2014) measured infants' attributions of happiness and sadness using a violation-of-expectation paradigm, whereas Chiarella and Poulin-Dubois (2013) evaluated infants' attributions of happiness, sadness, and pain using social referencing behaviors (i.e., back-and-forth looking from referent to experimenter) and Hepach and Westermann (2013) assessed infants' sympathetic arousal via pupil dilation to others' expressions of happiness and anger. Such differences have likely contributed to the wide developmental window through which this ability appears to emerge. In short, research using multiple emotions and similar methodologies is needed to compare results across studies.

Infants' Understanding of Goals

Studies often include facial and vocal expressions of emotion to manipulate how infants interpret others' goals. However, insufficient attention has been given to the potentially facilitative role such expressions might play in goal perception.

Consider infants' distinct responses to adults communicating differing intentions. Nine-month-olds responded with impatience (i.e., more reaching, looking away) to an experimenter who was unwilling to share a toy, but not to an experimenter who was willing but unable to share a toy (Behne et al., 2005). The experimenter's unwilling, unable, and distracted dispositions were conveyed, in large part, by varying facial expressions accompanying the experimenter's action (e.g., unwilling = smiling while retracting an object; unable = frowning while accidentally dropping an object; distracted = neutral while pulling the object away and talking to another person). It is possible that infants' perception of the experimenter's intentions (i.e., their understanding of goals) was enabled by relating the emotion signals they observed to each context.

Similarly, 14- to 18-month-olds observed an experimenter perform novel actions on objects accompanied by the vocalization, "Woops!" (accidental) or "There!" (intentional), both of which were expressed using affective intonation (Carpenter et al., 1998). When allowed to interact with the objects, infants were twice as likely to perform the intentional actions than the accidental actions. These results suggest that infants use others' emotional expressions to clarify the relational significance of others' ambiguous intentions (see also Striano & Vaish, 2006). It is possible that infants lacking such appreciation of emotional expressions would respond similarly to these tasks regardless of which emotion they observed.

Furthermore, goal-directed behavior alone often indicates underlying relational significance, which can provide infants sufficient information to clarify uncertain action outcomes in the absence of prototypic affective cues (e.g., facial expressions). For example, relational significance can be signaled through persistent actions (see Premack & Premack, 1994), as shown in studies using the behavioral reenactment procedure.

In one such study (Meltzoff, 1995), 18-month-olds observed an experimenter with neutral facial affect attempt repeatedly, but fail, to perform target actions on novel objects. Infants who observed the failed attempts were significantly more likely to perform the target action than those who did not observe a demonstration, failed or otherwise. It is possible that infants inferred the experimenter's true intention by interpreting the experimenter's persistent actions as frustration with a goal, a relationally significant cue, and thus imitated the intended action. In addition, because emotions often clarify the significance of others' goal-directed actions, including an expression of negative affect by the experimenter after each failed attempt could further disambiguate the experimenter's (failed) intention. As such, it is possible that incorporating negative emotion cues would facilitate increased successful imitation of the intended action, particularly for younger infants who may need more salient cues to interpret the outcomes of others' actions (see Bahrick & Lickliter, 2000).

Conversely, adding positive emotion cues after each action could lead infants to believe that the experimenter's intention was to perform the so-called failed action (see Meltzoff, Gopnik, & Repacholi, 1999). Indeed, in similar imitation paradigms using vocal and facial cues, infants were less likely to imitate actions perceived as accidental (Carpenter et al., 1998) or performed jokingly (Hoicka & Gattis, 2008). Such research highlights the need to examine carefully the effect of emotion signals on infants' interpretations of others' goal-directed actions.

Infants' Understanding of False Beliefs

How one appraises the environment is closely linked with the emotions one experiences. However, the beliefs underlying such appraisals can be mistaken. Infants understand false beliefs implicitly by at least the end of their first year (Baillargeon, Scott, & Bian, 2016) and children can typically reason about others' false beliefs after age 4 (Wellman, Cross, & Watson, 2001). However, research on understanding belief-based emotions is scarce, especially in infancy.

Research using verbal tasks indicates that children do not accurately predict the emotional responses of an individual with a false belief until age 6 (Harris, Johnson, Hutton, Andrews, & Cooke, 1989), whereas research using observational measures demonstrates that 2½- to 3-year-olds express suspense (e.g., increasingly opening their mouths, furrowing their brows) when observing an agent act on a false belief (Moll, Kane, McGowan, 2016; Moll, Khalulyan, & Moffett, 2017). Recent research suggests that even infants may understand belief-based emotions. In one such study (Knudsen & Liszkowski, 2013), 12- and 18-month-olds warned an experimenter of the unintended presence of an object toward which she had previously expressed disgust or pain. Interestingly, infants did not warn the experimenter if she had previously expressed positive affect toward the object, which may have signaled her lack of concern regarding potential future encounters.

Another study (Buttelmann et al., 2008) suggests that infants can reconcile conflicting emotional information when observing a social partner with a false belief: 18-month-olds observed an experimenter express positive emotion toward an object (i.e., a plush toy). Subsequently, infants watched the experimenter express frustration after not being able to open a box that he mistakenly believed contained the object. Infants responded prosocially by redirecting the experimenter to the actual location of the toy. In addition to appreciating the experimenter's (false) belief, it is possible that infants relied on the experimenter's positive affect toward the toy to infer his goal to reestablish this relation. However, had the experimenter previously expressed disgust or fear toward the object, infants may have been less likely to redirect him to its true location because doing so would have caused the experimenter distress. Additional research is needed to examine how other discrete emotions help infants respond adaptively to others' false beliefs, particularly when previously observed affect may disambiguate the mental states of a social partner with mistaken beliefs about the environment.

Research using looking-time measures provides additional evidence that infants understand belief-based emotions. Twenty-month-olds expected an agent to respond with a surprised expression instead of a neutral, satisfied, or happy expression upon realizing that she was mistaken about whether a toy made a certain sound or whether a box contained a particular object (Scott, 2017). However, research has yet to explore infants' expectations of others' emotional expressions as a function of ongoing false beliefs about the environment. For example, an infant with an understanding of belief-based emotions would expect an agent who mistakenly believes that she has won a game (but has unknowingly lost) to express joy (an emotion matching her beliefs) rather than sadness (an emotion matching the infant's beliefs).

Conclusion

Emotion understanding and social cognition are fundamentally intertwined. Studying these processes together can provide a more complete picture of how infants navigate social interactions. In the above review, I have highlighted three areas of social-cognitive research that could benefit from additional examination of the role of emotion understanding in infants' appreciation of others' mental states and actions: infants' action understanding, goal understanding, and false-belief understanding. In the following three chapters, I present three experiments that empirically investigated these connections.

Chapter 2

Chapter Abstract

This study investigated infants' sensitivity to others' congruent and incongruent emotional reactions to positive and negative events. Thirty-six 12-month-old infants viewed three distinct interpersonal events (give a toy, break a toy, fight over a toy) followed by an emotional expression (happiness, sadness, anger) that was either congruent or incongruent with the preceding event outcome. The duration of infants' looking toward each emotional reaction was examined. Infants demonstrated sensitivity to incongruent emotional reactions for the give and fight events, representing the earliest evidence to date of emotional sensitivity to negative events.

Introduction

Understanding others' emotions is essential for social competency and involves anticipating, appreciating, and responding appropriately to others' affective communication (Saarni, 1999). A substantial body of research exists examining infants' discrimination of affect (see Walker-Andrews, 1997), social referencing (see Walle, Reschke, & Knothe, 2017), and responding to others' emotions (see Walle & Campos, 2012). However, research examining infants' sensitivity to others' emotional reactions to specific events remains limited and was the focus of the present investigation.

Infants' sensitivity to the congruency of emotions and event outcomes develops between 8- and 18-months of age. Previous research found that 10-month-olds, but not 8-month-olds, looked longer at an agent's sad expression than at a happy expression following a positive event outcome (e.g., arriving at a desired location), but both age groups looked equally at these expressions following a negative outcome (Skerry & Spelke, 2014). Other work using pupil dilation to index sympathetic arousal found that 10- and 14-month-olds detected incongruent emotions when observing an angry actor perform a positive action (i.e., patting a toy tiger while scowling), but only 14-month-olds detected emotional incongruency when observing a happy actor perform a negative action (i.e., thumping the toy while smiling; Hepach & Westermann, 2013). Additional research with older infants found that 18-month-olds, but not 15-month-olds, increased their visual checking behaviors when observing positive reactions to negative events and negative reactions to positive events, and did not deem neutral reactions to negative events as incongruent (Chiarella & Poulin-Dubois, 2013, 2015). Thus, infants appear to be sensitive to events eliciting positive emotions at 10 months but are not sensitive to events eliciting negative emotions until 14-18-months of age.

This age discrepancy may be due to a number of methodological differences. First, studies have been inconsistent in their use of negative emotions, giving a fragmented picture of emotional development. For example, some studies use anger, a negative emotion high in arousal, whereas other studies use sadness, an emotion low in arousal (see Russell & Bullock, 1985). Second, studies of 8- to 14-month-olds have used *intrapersonal* events (Skerry & Spelke, 2014; Hepach & Westermann, 2013), whereas studies of older infants have used *interpersonal* events (Chiarella & Poulin-Dubois, 2013, 2015). The social nature of emotion may suggest that infants more readily appreciate affect in interpersonal contexts (Walle & Campos, 2012). Finally, previous studies have differed in their selection of dependent variables (i.e., looking behavior, pupil dilation, visual checking), making it difficult to compare results across experiments.

To address some of the above issues, the present study included one positive emotion response and two negative emotion responses, sadness and anger, allowing comparison between three discrete emotions varying in valence and arousal. Additionally, interpersonal emotion contexts were used (giving a toy, breaking a toy, and fighting over a toy). Twelve-month-old infants were tested using a violation-of-expectation procedure, a paradigm in which 10-month-olds have demonstrated sensitivity to others' incongruent emotional reactions to positive, but not negative, events (Skerry & Spelke, 2014). Additionally, prior research demonstrates that infants at this age can discriminate each of the included facial expressions (see Flom & Bahrick, 2007).

Method

Participants

Thirty-six 12-month-old infants (M = 11.8 months, SD = 0.48; 17 females) completed the study. Twenty-six participants were Caucasian, 8 were Hispanic, 1 was Asian, and 1 was African American. Participants came from socioeconomically diverse backgrounds, with average family income being $50,000 (range: <$25,000 to >$150,000 per year) and primary caregiver education ranging from no high school to a graduate degree. Thirty additional participants were tested but excluded because of fussiness (n = 7), sibling distraction (n = 6), inattentiveness to events (n = 5), procedural error (n = 4), parental interference (n = 4), external noise (n = 3), and equipment failure (n = 1).

Apparatus

Infants sat in a highchair or on their caregiver's lap at a table approximately 0.5 m across from a television monitor. Caregivers were instructed to not distract the infant. Other individuals accompanying the family were directed to sit quietly in a separate room. A webcam transmitted a live feed of the infant and caregiver to a separate computer.

Stimuli

Test stimuli consisted of three 8-second videos of a protagonist (P) and a social partner (S) sitting and engaging in one of three interpersonal events (give, break, fight; see Figure 1a). These events were selected based on their differences in core relational theme (see Lazarus, 1991) and strong association with a single emotion: give = obtaining a goal (happy), break = irrevocable loss (sad), fight = goal blockage that may be overcome (anger; see Barden, Zelko, Duncan, & Masters, 1980). S wore a yellow visor concealing her upper face and making her distinct from P. Both actresses expressed neutral affect during the following events:

Give event. S looked at and held, but did not play with, a triangle toy. S turned to P and handed her the toy. P took the toy, turned it upside down, and watched a moveable wheel spin.

Break event. P looked at a plush bunny and made it "dance." S looked toward P, took the bunny from P, tore off the bunny's leg, and set it down on the table.

Fight event. P looked at a stuffed caterpillar and made it "gallop." S looked at the toy and tried to take it from P, who pulled it back. P and S tugged the toy back-and-forth three times.

Each event was immediately followed by a static, close-up image of P displaying an affective expression (happy, sad, angry; see Figure 1b). Twenty-three undergraduate students (13 females, mean age = 20.00 years) independently viewed and categorized each facial expression as expressing joy, sadness, fear, anger, disgust, or surprise. All expressions were recognized as conveying the intended emotion (range: 91%-100%).

Figure 1. Screenshots of the event (a) and emotion (b) stimuli used in Experiment 1. For each test trial, infants observed an event followed by an affective expression.

Design

Nine possible event-emotion pairings were derived from the events and emotional reactions. Pairings were separated into three unique conditions, each comprised of one congruent pairing and two incongruent pairings. This ensured that infants viewed each event and emotion only once, thus minimizing familiarization effects across trials. Infants were randomly assigned to the following conditions (congruent pairing bolded): Condition 1 = **give-happy**, break-angry, and fight-sad (n = 12); Condition 2 = give-angry, **break-sad**, fight-happy (n = 12); Condition 3 = give-sad, break-happy, **fight-angry** (n = 12). The ordering of pairings within each condition was randomized. It was predicted that infants would look longer to incongruent pairings than congruent pairings. The prediction of infants' sensitivity to incongruent negative reactions to negative events (e.g. sadness following the fight event) are based on theoretical (Lazarus, 1991) and empirical work (Barden et al., 1980) suggesting that not all negative emotions are equally appropriate responses to negative events.

Procedure

A researcher naïve to conditions regulated the flow of stimuli using customizable Python software (Peirce, 2007) by viewing the live video feed and pressing a keyboard button when the infant attended to the screen. The stimuli flow consisted of the following trials:

Baseline. A novel, 14-s audio-visual presentation was displayed to elicit infants' attention toward the screen. Infants were shown each static affective expression of P twice in a randomized order to provide a baseline index of infants' general attention to visual stimuli. Baseline trials were displayed until the infant looked away consecutively for 2 s, and each trial was separated by a 4-s countdown audio-visual trial that directed attention to the screen.

Test. Following the baseline trials, infants watched another novel 14-s reorienting presentation. Infants then observed an event (give, break, fight) immediately followed by a still image of P conveying a facial expression (happy, sad, angry). This image was displayed until the infant looked away consecutively for 2 s, at which point another 14-s reorienting presentation was shown. This process repeated until infants saw the remaining event-emotion pairings in their assigned condition. No infants looked for the maximum trial length of 45 s in baseline or test trials.

Coding

An experimenter naïve to the hypotheses and conditions viewed the recordings offline and coded frame-by-frame the total amount of time infants looked toward the monitor during each static face presentation (baseline and after each test event). A second experimenter, blind to conditions, coded 20% of trials offline (interrater agreement: r = .93). Infants who were prematurely advanced by the online coder, thus not meeting the 2-s look away criteria, were excluded for procedural error.

Results

Data were log-transformed prior to the analyses to reduce positive skew (see Csibra, Hernik, Mascaro, Tatone, & Lengyel, 2016). Preliminary analyses revealed that infant looking time did not differ significantly as a function of trial, gender, or lap placement (highchair vs. lap), *p*s > .16. Thus, subsequent analyses were collapsed across these variables.

Infant looking time was analyzed using a repeated-measures analysis of covariance (ANCOVA) with event (give, break, and fight) and emotion (happy, sad, angry) as within-subjects factors. Infants' averaged looking to the baseline trials was included as a covariate to control for individual differences in attention to visual stimuli. Excluding the covariate did not change the pattern of results (see Table 1).

Table 1.

Results of ANCOVA in Experiment 1 for the factors of Event and Emotion with Baseline looking as a covariate.

	F	p	η_p^2
Main Effects			
Event	1.17	.32	.023
Emotion	.88	.42	.018
Event × Emotion	6.22	< .001	.202
Covariates			
Baseline	12.36	.001	.11

The ANCOVA revealed no main effects of event, $F(2, 98) = 1.17$, $p = .32$, $\eta_p^2 = .023$, or emotion, $F(2, 98) = .88$, $p = .42$, $\eta_p^2 = .018$. Central to the hypotheses, a significant Event × Emotion interaction was present, $F(4, 98) = 6.22$, $p < .001$, $\eta_p^2 = .202$ (see Figure 2). Specifically, within the give event, infants looked significantly longer to the angry face ($M = 6.50$, $SE = 1.15$) than the happy face ($M = 2.81$, $SE = 1.16$), $t(22) = 4.15$, $p < .001$, $d = 1.77$, 95% CI = [0.42, 1.26], significantly longer to the angry face than the sad face ($M = 4.23$, $SE = 1.16$), $t(22) = 2.12$, $p = .046$, $d = 0.90$, 95% CI = [0.01, 0.85], and longer to the sad face than the happy face, though this difference did not reach statistical significance, $t(22) = 1.98$, $p = .06$, $d = 0.84$, 95% CI = [-0.02, 0.83], and thus did not fully support the prediction. Following the fight event, infants looked significantly longer to the happy face (*M* = 7.01, *SE* = 1.15) than the angry face (*M* = 4.28, *SE* = 1.15), *t*(22) = 2.52, *p* = .02, *d* = 1.07, 95% CI = [0.09, 0.90], supporting the hypotheses, and also longer to the happy face than the sad face (*M* = 4.33, *SE* = 1.15), *t*(22) = 2.43, *p* = .02, *d* = 1.04, 95% CI = [0.07, 0.89]. However, contrary to predictions, infant looking to angry and sad faces after the fight event did not differ, *p* = .95, and no significant differences were observed in infants' looking to emotion faces following the break event, *p*s > .26.

To verify that a small number of infants with extreme looking time scores in each condition were not responsible for the findings, non-parametric tests were used to examine how many infants exhibited the above patterns in the give and fight events. Individual looking times in each comparison group were compared to the group mean of the other group to tally how many infants exhibited the observed group patterns. Results indicated that a majority of infants demonstrated the patterns at the individual level (range: 18/24 to 23/24, all *p*s < .05, two-tailed binomial tests), confirming the pattern of findings from the ANCOVA.

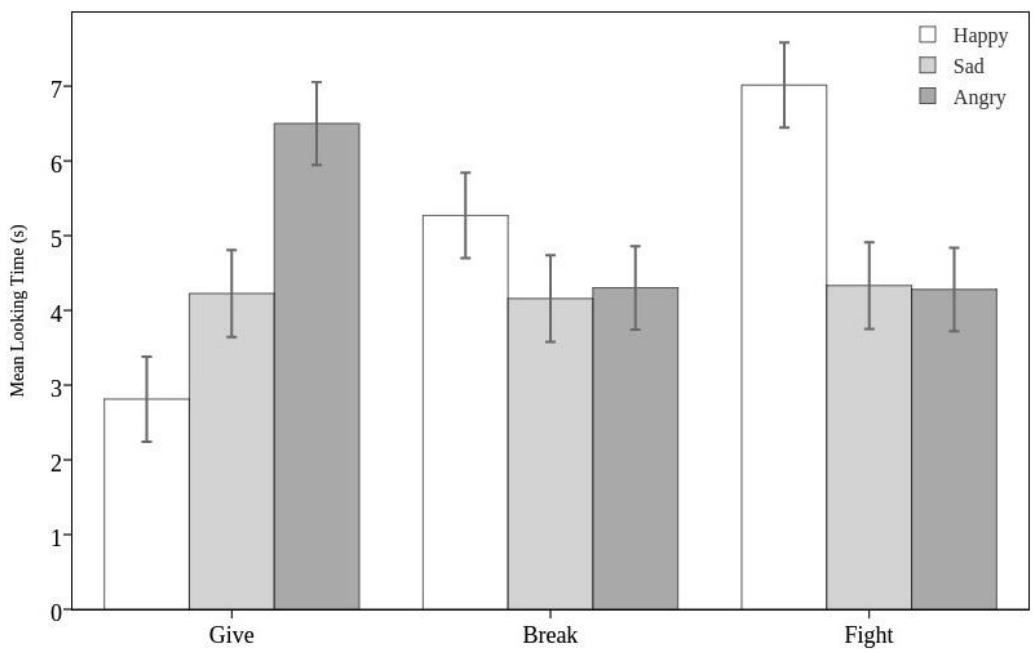


Figure 2. Results of Experiment 1. Estimated Marginal Means of infant looking time to Happy, Sad, and Angry emotions as a function of event. Error bars represent 95% CI.

Discussion

Infants demonstrated sensitivity to another individual's incongruent emotional responses to two of three interpersonal events. In support of the predictions, infants looked longer at a protagonist's angry facial expressions after being given a toy than when she conveyed a happy facial expression. A similar difference was present when sadness followed the give event, but this effect fell short of reaching statistical significance. Additionally, infants looked longer at an angry expression than a sad expression following the give event. This may be because anger was both unexpected for this event *and* high in arousal, resulting in increased infant attention (Russell & Bullock, 1985).

In partial support of the predictions, infants looked longer at a happy facial expression than an angry or sad facial expression after observing individuals fighting over a toy. However, contrary to the hypotheses, infants did not differentiate between the anger and sadness emotions following the fight event. It is possible that infants first perceived the fight event as ongoing goal blockage but interpreted the pause at the end as an indication of "giving up" (see Barden et al., 1980). Thus, infants may have expected either sadness or anger as immediate responses to this event. Finally, inconsistent with the predictions, infants did not exhibit differential looking toward affective facial expressions following the breaking of a toy. It is possible that infants' understanding of the emotional consequents of "breaking" actions emerges later in development (e.g., Chiarella & Poulin-Dubois, 2013), possibly due to infants' infrequent experiences of irrevocable loss at this age compared to other experiences, such as goal blockage (Biringen, Emde, Campos, & Appelbaum, 1995).

This is the first study to demonstrate that infants as young as 12 months of age are sensitive to emotionally incongruent responses to positive (i.e., give) and negative (i.e., fight) interpersonal events. This capacity had previously not been found until 18 months of age, possibly due to the nature of the interpersonal events used (e.g., whole person vs. arm; Chiarella & Poulin-Dubois, 2013). Moreover, these results extend prior research indicating that 10-month-olds detect emotion incongruency following positive events, but not negative events (Skerry & Spelke, 2014; Hepach & Westermann, 2013).

These results have important implications for understanding infant emotional development. First, infant sensitivity to event-emotion congruency may be contingent on understanding goal-directed actions (see Reschke, Walle, & Dukes, 2017). Research suggests that understanding successful intentional actions precedes understanding failed actions, with the latter emerging at 10 months (Brandone & Wellman, 2009). The current findings paired with previous research using looking time suggest that infants' emotional expectations of successful and failed actions may follow this sequential unfolding. Indeed, although the 10-month-olds in previous research (Skerry & Spelke, 2014) and the 12-month-olds of the current study likely appreciated failed intentional actions, only the 12-month-olds demonstrated detected affective incongruency in both positive and negative events. Research using diverse measures of infants' emotional sensitivity (e.g., pupil dilation, checking behaviors) is needed to confirm this possibility.

Second, infants' sensitivity to others' emotions may be associated with their own emotional experiences (see Walle & Campos, 2012). Infants demonstrate increased social autonomy between 11 and 14 months, which corresponds with increased parental prohibitions (Biringen et al., 1995). As such, 12-month-olds may be more experienced with their goals being accomplished or frustrated by social partners than 10-month-olds, and thus are better able to appreciate interpersonal relations in social contexts. Alternatively, the goal-relations of these events may have been easier to comprehend than the negative events in previous research, such as when an agent's "intended" action is not directly observed (Skerry & Spelke, 2014) or when the goal is more ambiguous (Hepach & Westermann, 2013). However, the scope of the present study prevents conclusions regarding these possibilities.

These findings provide the earliest evidence of infants' sensitivity to others' incongruent affective reactions to both negative and positive events. Further research is needed to investigate the developmental unfolding of infants' appreciation of emotion elicitors. We advocate that future studies include additional interpersonal events and discrete emotional outcomes (e.g., disgust, fear), assess concurrent infant cognitive functioning (e.g., goal understanding), and explore infant social behaviors that may facilitate the development of such understanding.

Chapter 3

Chapter Abstract

Infants readily imitate others' intended actions during the second year of life (Meltzoff, 1995). However, the role of emotion in appreciating others' intentions and how this understanding may develop in infancy remains understudied. In this study, 15- and 18-month-old infants observed an experimenter repeatedly attempt but fail to produce a target action on an object and then express either frustration or neutral affect. Analyses of infants' imitations of the target actions revealed that 18-month-old infants, but not 15-month-olds, imitated more target actions in the frustration condition than in the neutral condition. These results suggest that the ability to use others' emotions to disambiguate and imitate others' intentions develops in the first year of life.

Introduction

An essential characteristic of psychological reasoning is the ability to attribute motivational states to other agents (Baillargeon et al., 2016). Similarly, a core component of emotion understanding is perceiving others' significant relations between their goals and the environment (Reschke et al., 2017). Research on adult social cognition has demonstrated major conceptual and neural overlap of emotion understanding and intentional behavior (Lewis & Todd, 2005; Freeman, 2000). However, research investigating this overlap in infancy is scarce. This study examined the effect of emotional communication on infants' imitative responses to others' unintended actions.

Infants' ability to imitate others' intended actions develops markedly during the first two years of life. Research has demonstrated that infants can readily imitate others' object-directed actions by 6 months (Barr, Dowden, & Hayne, 1996; see also Meltzoff, 1985) and can visually discriminate between complete and incomplete actions by 10 months of age (Brandone & Wellman, 2009; Brandone et al., 2014; Hamlin et al., 2009; Striano & Vaish, 2006). However, it is not until the second year of life that infants are able to infer and imitate others' intended actions. In a classic study by Meltzoff (1995), 18-month-old infants observed an experimenter with a neutral expression repeatedly attempt but fail to produce a target action on a novel object (e.g., try but fail to activate a buzzer with a baton). Despite only observing the experimenter's failed attempts, infants were able to reenact the unobserved intended actions (e.g., activate the buzzer using the baton) and did so at a frequency equal to infants who had observed the experimenter model successful target actions. Other studies using the behavioral reenactment procedure have shown that the ability to imitate others' intended actions emerges by at least 15 months of age (Johnson, Booth, & O'Hearn, 2001; Bellagamba & Tomasello, 1999; Bellagamba, Camaioni, & Colonnesi, 2006), though might appear as early as 12 months if simpler objects and actions are used (Nielsen, 2009; Legerstee & Markova, 2008). Taken together, these studies suggest that the ability to imitate others' intended actions emerges early during the second year of life.

Imitation of intended actions is connected to emotion understanding in at least two ways. First, although studies using the behavioral reenactment procedure explicitly omit overt expressions of emotion (e.g., Bellagamba , Camaioni, & Colonnesi, 2006), their inclusion of persistent, varied actions conveys relational significance relevant to goal blockage (Premack & Premack, 1994; Reschke et al., 2017). Thus, even the absence of overt facial expressions does not preclude the communication of relational significance through other means. Second, imitation studies that explicitly manipulate various motivational states ("accidental," "intentional," "joking") do so in large part by systematically varying emotionally-relevant cues, such as vocal prosody (e.g., Sakkalou & Gattis, 2012; Carpenter et al., 1998), facial expressions (Király, 2009), and combinations of emotion cues (Repacholi, 2009; Hoicka & Gattis, 2008). However, these studies examined infants' use of emotional communication to imitate actions that they observed. Thus, it remains an open question whether emotional communication enhances infants' ability to infer and imitate others' unobserved intended actions.

The Present Study

This study employed a modified behavioral reenactment procedure to examine the influence of emotional cues on 15- and 18-month-old infants responding to an agent's unintended actions. Specifically, infants observed an experimenter attempt and fail three times to complete target actions involving five objects (Melztoff, 1995). Novel to the present study, the experimenter expressed either frustration or neutral affect after each failed attempt. Previous research has shown that the behavioral reenactment procedure is appropriate for this age range (Johnson et al., 2001; Olineck & Poulin-Dubois, 2009; Bellagamba et al., 2006), and that infants can readily regulate their behavior towards objects based on an experimenter's emotional cues (Repacholi, 2009). Infants' production of the target action (i.e., the unobserved action) was coded. It was predicted that infants would produce more imitations of target actions in the frustration condition than the neutral condition.

Method

Participants

Twenty 18-month-old infants (M_{age} = 18.01 months, *SD* = 0.52, Range: 17.15—18.76 months, 9 females) and 20 15-month-old infants (M_{age} = 14.79, *SD* = 0.53, Range: 14.09—15.80 months, 8 females) completed the study. The sample was ethnically and socioeconomically diverse. Nineteen participants were of Hispanic ethnicity, 16 were Caucasian, 1 was African American, 2 were "Other," and two did not provide racial information. Median family income was between $41,000-$60,000 (range: <$25,000 to >$150,000 per year) and median caregiver education level was a college degree (range: high school diploma to graduate degree). Due to experimenter error in modeling the actions, four 18-month-olds and four 15-month-olds provided data for only four of the five trials and one 15-month old provided only three of the five trials. These infants were retained in the sample. Two additional 18-month-old infants and two additional 15-month-old infants were tested but excluded because of fussiness (n = 2) and having three or more dropped trials due to experimenter error in displaying the emotions (n = 2).

Design

Infants were randomly assigned to the frustration condition or neutral condition. Object order was counterbalanced within each group.

Stimuli

Test objects. The test stimuli consisted of five novel handmade objects that were constructed from descriptions and images of other studies using the behavioral reenactment procedure (see Figure 3; Meltzoff, 1995; Yott & Poulin-Dubois, 2012).

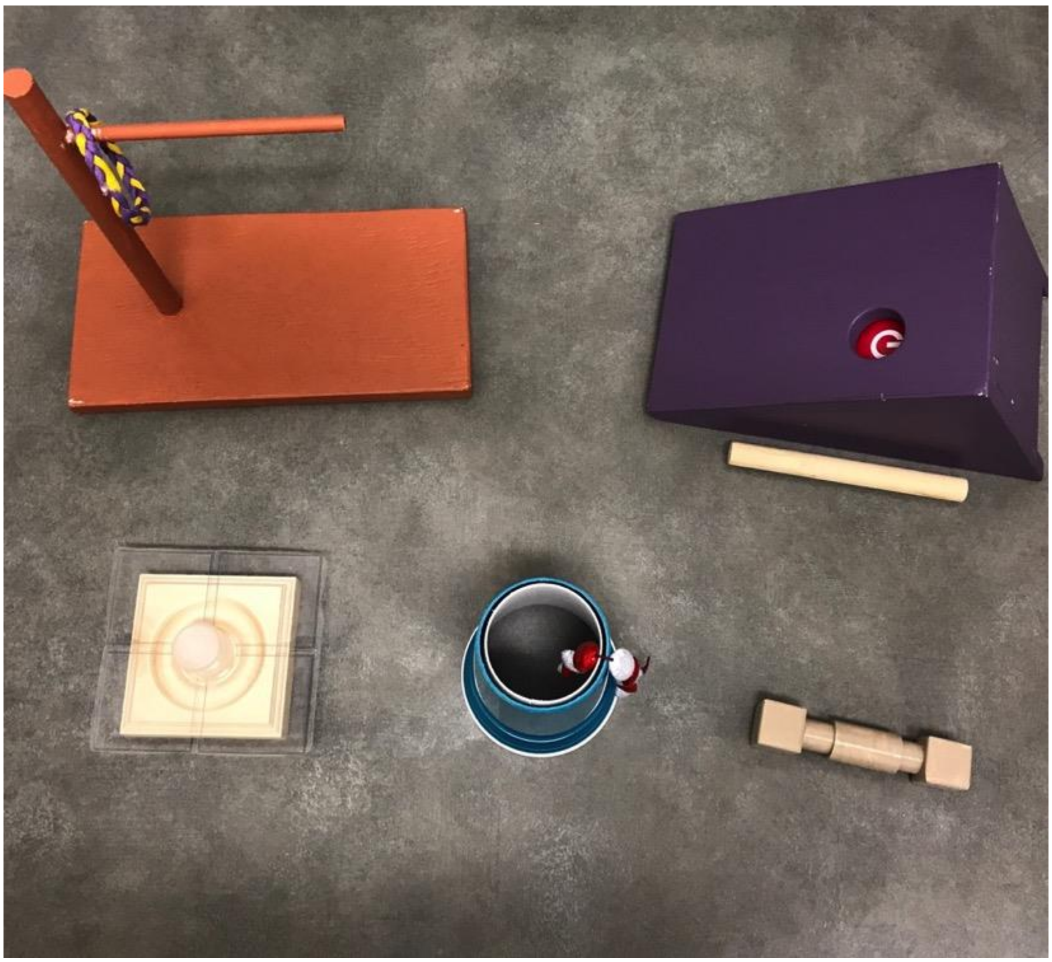


Figure 3. Stimuli used in the modified behavioral re-enactment task in Experiment 2 (order from left to right, top to bottom): Prong, Box, Base, Container, and Dumbbell.

Emotional expressions. A female experimenter presented each stimulus and expressed either frustration or neutral affect for approximately 2 s following each failed action. For the frustrated expression, the experimenter first clicked her tongue, displayed a frustrated facial expression (i.e., raised cheeks, crinkled eyebrows, and mildly squinted eyes), and then produced a rapid exhalation. For the neutral expression, the experimenter's cheeks, eyebrows, and eyes remained neutral and the experimenter did not produce any vocalizations, thus reproducing the condition in the standard behavioral reenactment procedure (Meltzoff, 1995).

Procedure

The caregiver and child were first brought to a room with toys. The caregiver filled out questionnaires while the infant acclimated to the room. The caregiver and infant were then brought to a testing room and were directed to sit at a table with the infant on the caregiver's lap. The experimenter sat on the other end of the table, facing the caregiver and infant. The experimenter then introduced four warm-up toys (one plastic phone and three multi-colored balls of various shapes) separately to prime the infant to relinquish objects upon request and to reduce potential distress during the test trials. After this brief period (approximately 1-2 min), the experimenter discarded the warm-up toys and proceeded with the test trials.

Test trials. There were five test trials, each consisting of a demonstration phase and a 20-s response phase.

Demonstration phase. In each demonstration phase, the experimenter introduced one of the five test stimuli and attempted three times but failed to produce a target action on each object. These actions were modeled explicitly after the "demonstration (intention)" condition in Study 1 of Meltzoff (1995; see Table 2). Novel to the current study, the experimenter expressed either frustration or neutral affect for approximately 2 s after each failed attempt. To help ensure that infants attended to each demonstration, the experimenter was allowed to address infants directly prior to each action by saying the child's name or using the following phrases: "see what I have," or "look over here." Thus, the duration of each demonstration phase varied slightly across trials. Following the third demonstration, the experimenter placed the stimulus directly in front of the infant and said, "It's your turn."

Response phase. Each response phase began when the infant first touched the object or when the experimenter released the object, whichever occurred first. Each response phase concluded after 20 s had elapsed, the infant spontaneously returned the object to the experimenter, or the infant dropped the stimulus to the floor, whichever came first. During this time, the experimenter was instructed to look between the infant and the center of the table and maintain a neutral expression.

Table 2

Descriptions of target and observed actions in Experiment 2.

Object	Target Action	Observed Action
Prong	Place loop through tip of prong	Holding loop with one hand, drops loop near prong
Box	Touch wand to buzzer, activating sound	Holding wand with one hand, touches wand to area next to buzzer
Base	Place cover over knob and press down	Holding cover with both hands, drops cover to the side of knob
Container	Drop beads inside container	Holding beads with one hand, drops beads to side of container
Dumbbell	Separate ends of dumbbell	Holding dumbbell with both hands, one hand slips off end of dumbbell

Note: It was discovered during data collection that the dumbbell was unintentionally too difficult to separate for infants. In order to maintain the integrity of the data already collected, the dumbbell was not corrected, and the original dumbbell coding scheme (Meltzoff, 1995) was modified to include infants' clear attempts to separate the dumbbell. This coding scheme is similar to that described in Meltzoff et al. (1999), in which the dumbbell had been purposefully glued together to prevent infants from separating it.

Equipment

One camera situated behind the experimenter captured infants' behavioral responses. A second camera placed behind the infant and caregiver recorded the experimenter's emotional expressions and action demonstrations. An additional webcam placed on the edge of the table provided a live video feed of the interaction for the timekeeper, who remained hidden from view and communicated the end of each test trial to the experimenter by making a light tapping sound.

Coding

Infant target actions. Two researchers blind to conditions independently viewed all response phase trials and coded whether infants produced or did not produce the target action for each stimulus (see Table 2). Interrater reliability was excellent (Cohen's $\kappa = .95$; Landis & Koch, 1977).

Manipulation check. One coder independently viewed all demonstration trials to verify that the experimenter displayed the assigned emotion correctly. For two infants, the experimenter displayed the incorrect emotion for three of the five trials. These infants were not retained in the sample due to multiple instances of experimenter error. For four other infants, the experimenter displayed the incorrect emotion during one of the five trials. The four valid trials for these infants were retained in the sample. A second coder viewed the emotional expressions of a random 24% of the retained infants resulting in 98% agreement.

Results

Infants' target actions for each object were analyzed using separate repeated-measures mixed effects models for each age group, which were specified with a binomial distribution, a logit link, and a diagonal covariance matrix with emotion as a between-subjects factor. Each model used Restricted maximum likelihood (REML) and was able to include infants with partial data.

Preliminary analyses including the effects and interactions of infant gender and trial order with emotion yielded equivalent patterns and significance of results. Thus, these variables were collapsed in subsequent analyses.

Eighteen-month old infants

Critical to the hypotheses, there was a significant effect of emotion, $F(1, 94) = 4.63$, $p = .03$, $\eta_p^2 = .05$. Planned comparisons revealed that older infants imitated significantly more target actions in the frustration condition than the neutral condition, $t(94) = 2.23$, $p = .03$, 95% CI [0.02, 0.42] (see Figure 4).

Fifteen-month-old infants

Contrary to predictions, the effect of emotion was not significant, $F(1, 91) = .35$, $p = .55$, $\eta_p^2 = .004$. The younger infants imitated an equal number of target actions in the frustration and neutral conditions, $t(91) = .39$, $p = .70$, 95% CI [-0.16, 0.24] (see Figure 4).

Age Differences

It is possible that the effect of emotion for the older infants was not a result of frustration increasing imitation compared to baseline (i.e., neutral), but rather neutral affect decreasing imitation. To test this alternative explanation, 18-month-old infants' target actions in the neutral condition were compared to 15-month-old infants' targets actions in the frustration and neutral conditions. Results indicated that infants in these conditions produced equal numbers of target actions (ps > .47), suggesting that 18-month-old infants' target actions in the neutral condition can be treated as a "baseline rate" that is influenced by the addition of frustration. To test this explanation, the target actions of older infants in the frustration condition were compared to the target actions of all other infants (i.e., 18-month-olds in the neutral condition and all 15-month-old infants). Results indicated that 18-month-old infants in the frustration condition completed significantly more target actions than all other infants, $t(187) = 2.28$, $p = .02$, 95% CI [0.03, 0.35].

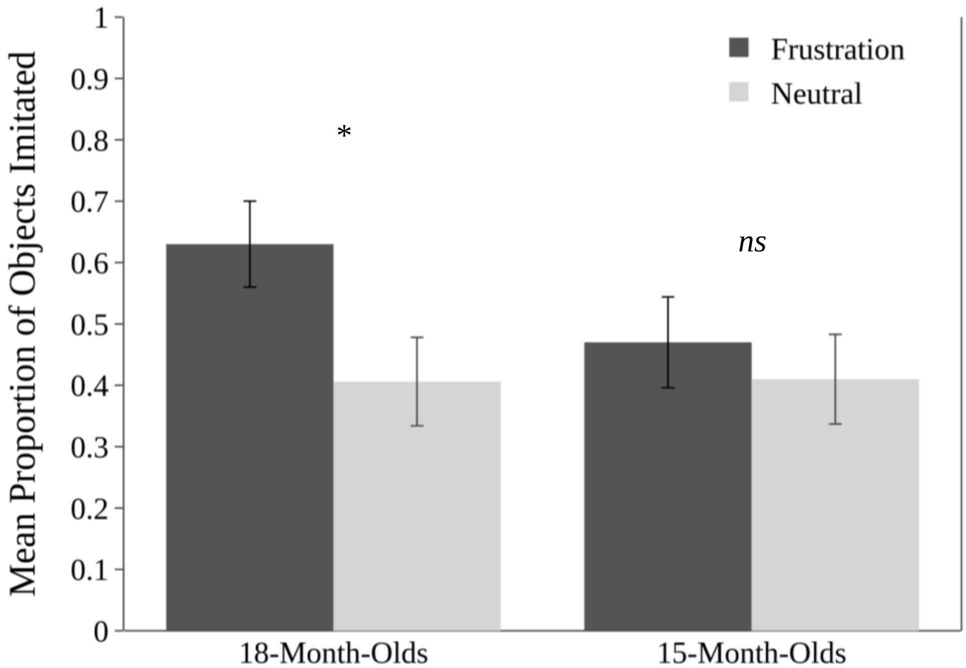


Figure 4. Results of Experiment 2. Estimated Marginal Mean proportions of 18- and 15-month-old infants' imitated target actions by emotion condition. Error bars represent *SE*s and an asterisk denotes a significant difference between emotion conditions ($p = .03$).

Discussion

This study is the first to demonstrate that emotional communication impacts infants' imitation of unobserved intended actions. These findings indicate that the ability to relate others' negative emotional expressions to their motivational states emerges in the middle of the second year of life. Specifically, and in partial support of the predictions, 18-month-old infants, but not 15-month-olds, used an experimenter's emotional reaction to disambiguate her failed intention and imitate her unobserved intended actions. Together, these results suggest that infants by 18 months of age are able to use emotional expressions to better infer others' goals.

These findings support and extend previous research in multiple ways. First, these results replicate findings from other studies showing that 15- and 18-month-old infants can infer and imitate others' intended actions. Although the rates of imitation from the current study are lower than those in the seminal study by Meltzoff (i.e., 0.84), these rates fall within the reported ranges of other labs that have used the behavioral reenactment procedure with similar ages

(Bellagamba & Tomasello, 1999; Yott & Poulin-Dubois, 2012; Johnson et al., 2001; range: 0.37 to 0.72).

Second, this study is the first to document the emergence of emotion-enhanced imitation. Both 15- and 18-month-old infants were able to infer and imitate an experimenter's intended actions with no added emotion, but only 18-month-old infants improved their imitation as a result of observing added negative emotional communication. It is possible that this age difference is due to task demands, with 15-month-old infants struggling to simultaneously attribute and process multiple mental states in addition to successfully planning and producing target actions. It is possible that the 15-month-old infants simply possess an underdeveloped appreciation of others' emotional communication. However, this explanation is unlikely given that 12-month-old infants are able to differentially respond to an uncertain context by referencing another's positive or negative emotional communication (Sorce, Emde, Campos, & Klinnert, 1985). Thus, 15-month-old-infants' failure may be due to a still-developing coordination between these interconnected systems.

Lastly, this study helps bridge research on infant social referencing and psychological reasoning. Social referencing research has typically investigated infants' proclivity to seek out emotional information from a social partner to better understand and respond to a shared referent, such as a toy (Repacholi, 2009), stranger (Boccia & Campos, 1989), or ambiguous situation (Sorce et al., 1985). One interpretation of the current results is that 18-month-old infants similarly referenced the experimenter's expression to disambiguate an ambiguous referent. In this case, the referent was the experimenter's goal-directed action and infants looked to the experimenter's emotional expression to clarify the relational significance of the experimenter and her environment (Reschke et al., 2017). This interpretation suggests that the referents involved in social referencing are not limited to physical objects in the environment, but also include others' mental states.

The current study only explored the effects of negative affect following unintended actions. Adding positive emotion cues after each action could lead infants to believe that the experimenter's intention was to perform the so-called failed action (see Meltzoff et al., 1999). Previous imitation paradigms using vocal and facial cues has shown that 25-to-36-month-old infants are more likely to imitate ambiguous object-directed actions accompanied with laughter (e.g., putting a hat over one's eyes jokingly or brushing one's teeth with the wrong end of a toothbrush) as opposed to negative affect (Hoicka & Gattis, 2008). However, infants' imitation of these actions may have relied on prior knowledge and experience with common household objects. Furthermore, infants' imitation in the laughter condition was of the observed action, and thus did not require infants to infer an unobserved intention. Additional research is needed to investigate the effect of positive emotional communication on infants' imitation of unobserved intentional actions on unfamiliar objects.

These findings provide evidence that emotion communication plays an increasingly influential role in interpreting others' intentions. Additional research is needed to explore the impact of other emotionally-relevant cues on infants' understanding of intentions and emotions, including ostension (Repacholi, 2009). For instance, it is possible that ostensive emotional communication in conjunction with a novel object-directed action might communicate qualitatively distinct relational significance (e.g., "I don't want you to do what I just did") than non-ostensive cues (e.g., "I didn't intend to do that. I meant to do something else"). In both instances, an observing infant might respond by not reenacting the observed action, but only in the latter instance is an infant more likely to actively infer and imitate the unobserved intended action. Furthermore, infants may differentially utilize emotionally ostensive communication across development as a function of their emerging understanding of social referencing (Brugger, Lariviere, Mumme, & Bushnell, 2007; Walle et al., 2017) and goal understanding (Király, 2009).

Chapter 4

Chapter Abstract

This study examined infants' understanding of others' belief-based emotions. Infants 20 months of age observed an experimenter obtain a true or false belief about the contents of a closed, opaque box. The experimenter later held the box and expressed an emotion congruent or incongruent with her belief about whether the box contained a desirable or undesirable object. Analyses of infants' looking patterns revealed that infants did not appear to demonstrate clear expectations regarding the experimenter's emotional reactions.

Introduction

> It was not long before the wolf arrived at the old woman's house…[T]he door opened, and then he immediately fell upon the good woman and ate her up in a moment…He then shut the door and got into the grandmother's bed, expecting Little Red Riding Hood, who came some time afterwards and knocked at the door. (Lang, 1889, pp. 51-52)

We experience emotions in accordance with our perceptions of the world, even if we are mistaken. For example, had Little Red Riding Hood known that the wolf was waiting for her in her grandmother's bed, she would have fled in terror. However, because she (falsely) believed that it was her grandmother who awaited her, she did not hesitate to enter the house, and was no doubt excited about the visit. As adults, we readily account for others' beliefs while predicting their emotional reactions. To make such *false-emotion attributions* is a hallmark of social cognition because it requires the perceiver to coordinate emotional and belief states simultaneously (Bradmetz & Schneider, 2004). Research investigating the origins of this ability has demonstrated that children cannot correctly predict the emotional reactions of others with false beliefs until 6 years of age (Harris et al., 1989; see also Bradmetz & Schneider, 1999, 2004). However, such research has largely employed verbal elicited-response tasks (Baillargeon, Scott, He, 2010), which limits our understanding of the development of this ability during infancy. To address this issue, this study used a nonverbal spontaneous-response paradigm to examine infants' sensitivity to an adult who responded with congruent or incongruent emotions to an event about which she held a true or false belief.

Infants' false-belief understanding and emotion understanding develop markedly during the first years of life. Research has shown that the ability to attribute counterfactual states to others emerges as early as 6 months of age (Southgate & Vernetti, 2014; Kovács, Téglás, & Endress, 2010). As this ability develops, infants are increasingly able to detect when others are mistaken and predict how they might behave in the future (Baillargeon et al., 2016). Infants' sensitivity to others' emotions also changes significantly during this time. Infants anticipate others' emotional responses to positive events as early as 10-to-12 months of age (Skerry & Spelke, 2014; Hepach & Westermann, 2013; Reschke, Walle, Flom, & Guenther, 2017) but are not sensitive to others' emotional responses to negative events until 12-to-18 months (Reschke, Walle, Flom, Guenther, 2017; Chiarella & Poulin-Dubois, 2013; Hepach & Westermann, 2013). Additionally, infants at 2.5 years of age have been shown to spontaneously express "suspense" (i.e., furrowing brow) when observing another agent about to make an unexpected discovery (Moll et al., 2017). Collectively, these studies suggest that infants can attribute false beliefs to others and evaluate others' emotional reactions to positive and negative events.

Some research provides evidence that infants may understand belief-based emotions. In one study, infants 12 and 18 months of age tended to warn an experimenter about the unknown presence of an object towards which she had previously expressed dislike. However, infants were less likely to warn if the experimenter had earlier expressed positive affect toward the object or was truly aware of the object's location (Knudsen & Liszkowski, 2013). One explanation of these findings is that infants warned the experimenter about the object because they appreciated her belief about the situation and her likely emotional reaction should she reencounter the object. Alternatively, infants may have spontaneously produced such gestures based on belief and goal attributions alone, without anticipating the experimenter's emotional reaction.

In another study, 20-month-old infants observed an experimenter discover that she was previously mistaken about a container's noise-making quality or the contents of a box. The experimenter then responded with an emotion congruent or incongruent with the event. Results indicated that infants expected the experimenter to respond emotionally with surprise instead of neutral, satisfied, or happy affect (Scott, 2017). Importantly, the emotional attributions infants made in this study were ultimately of an agent's true belief, since the agent no longer held a false belief at the time of the emotional reaction (i.e., *after* discovering that she was mistaken). Thus, it remains an open question as to whether infants can make false-emotion attributions to other agents.

To address this question, this study employed a novel violation-of-expectation paradigm to examine infants' emotion attributions of current false beliefs. Infants observed an experimenter respond emotionally to a box containing either a desirable object or undesirable object about which she had a true or false belief. Infants who expect the agent to respond emotionally in accordance with her beliefs are expected to demonstrate such understanding by looking longer when the experimenter expresses an emotion incongruent with her belief (e.g., responding with excitement to a box she believes contains an undesirable object) as opposed to an emotion congruent with her belief (e.g., responding with excitement to a box she believes contains a desirable object).

Findings supporting these hypotheses would contribute to the growing literature on infant psychological reasoning in two ways. First, a successful false-emotion attribution to another agent requires the perceiver to mentally represent both the agent's belief and emotional state. If infants demonstrate such understanding, it would provide additional evidence that infants, like children, can ascribe a variety of mental states to other agents, including false-emotion attributions. Second, prior research using verbal elicited-response tasks suggests that the ability to make false-emotion attributions develops in later childhood (Bradmetz & Schneider, 2004). However, the use of a nonverbal spontaneous-response design may reveal, as has been shown in the field of false-belief understanding (Baillargeon et al., 2010; Wellman et al., 2001), that this skill emerges far earlier than previously supposed.

Method

Participants

Participants were 28 infants (M_{age} = 19.93 months, *SD* = 1.25, Range: 18.07—21.91 months, 14 female). Eleven participants were Hispanic, 9 were Caucasian, 2, were Asian, 1 was African American, 2 were Mixed Race, and 1 was "Other." Median annual family income was $41,000-$60,000 (range: <$25,000 to >$150,000) and median caregiver education level was a college degree (range: high school diploma to graduate degree). Nine infants included in the sample provided data for only one of the two test trials due to experimenter error (*n* = 8) and fussiness (*n* = 1). An additional 8 infants were tested but excluded due to experimental error (*n* = 5), fussiness (*n* = 1), equipment failure (*n* = 1), or infant inattention (*n* = 1).

Stimuli

The stimuli consisted of five video clips filmed using a high definition camcorder: one 21-s preference trial and four 66-s test trials (see below). Examples of the stimuli are presented in Figures 4 and 5.

Preference trial. In the preference trial, an emoter (E1) sat at a table with two objects in front of her, a desirable object (i.e., an attractive 12 cm × 12 cm blue ball with sparkly blue tentacles) on the table to her left and an undesirable object (i.e., a 12 cm × 8 cm × 3 cm black rubber rectangle) on the table to her right (see Figure 5). E1 then leaned over and looked at the desirable object (1 s) and facially and vocally expressed excitement (i.e., smiling and saying, "ooh!") for 3 s and then turned and looked at the undesirable object (1 s) and facially and vocally expressed disdain (i.e., a disgusted look and saying, "eck!") for 3 s. E then repeated these actions in the same order (8 s) and then looked at the table between the objects with a neutral facial expression (1 s). The scene then paused.

Figure 5. Events shown in the preference trial of Experiment 3. Infants observed an experimenter express excitement toward an attractive, colorful ball and disappointment toward a black rectangle.

Test trials. In each test trial, E1 sat at a table with a 15 cm × 15 cm × 15 cm opaque, lidded box on the center of the table (See Figure 6). Behind E1 were two closed doors. E1 first looked at the box (1 s), opened the lid (3 s), peered inside (1 s), turned the box over with a shaking motion to indicate that it was empty (3 s), set the box back on the table and replaced the lid (4 s), and then turned and looked at the center of the table with a neutral facial expression (2 s). A second experimenter (E2) opened the door on the right of E1 (2 s) and entered the room carrying an opaque 30 cm × 30 cm × 15 cm bag and set it on the table (4 s). E2 opened the box and set the lid on the table (4 s). E2 then opened the bag (1 s), removed an object (desirable or undesirable, 2 s), placed it in the box (2 s), and replaced the lid (2 s), setting the box on the center of the table (3 s). A doorbell then chimed (1 s) and E1 stood up to open the other door and exited (6 s), closing the door behind her (2 s).

In the *false-belief condition*, E2 then opened the box and set the lid on the table (4 s), removed the ball from the box (2 s), and switched it with the rectangle in the bag (3 s). E2 then closed the box (3 s), set it back on the table (1 s), and exited the room through the same door she entered (2 s). E1 then returned to the room (3 s), sat down (2 s), and picked up the box (1 s), but did not open it. The video then cut to a close-up of E1's head and torso. E1 expressed either excitement or disappointment while holding and looking at the box (2 s). The scene then paused.

In the *true-belief condition*, E1 immediately returned to the room after closing the door (3 s), sat down (2 s), and watched E2 switch the objects and exit the room (15 s). E1 then picked up the box (1 s) and expressed excitement or disappointment (2 s).

The timing of the false-belief and true-belief conditions was identical up until the door closed following E1's exit. The total duration for all test trials was identical across combinations of beliefs, emotions, and objects.

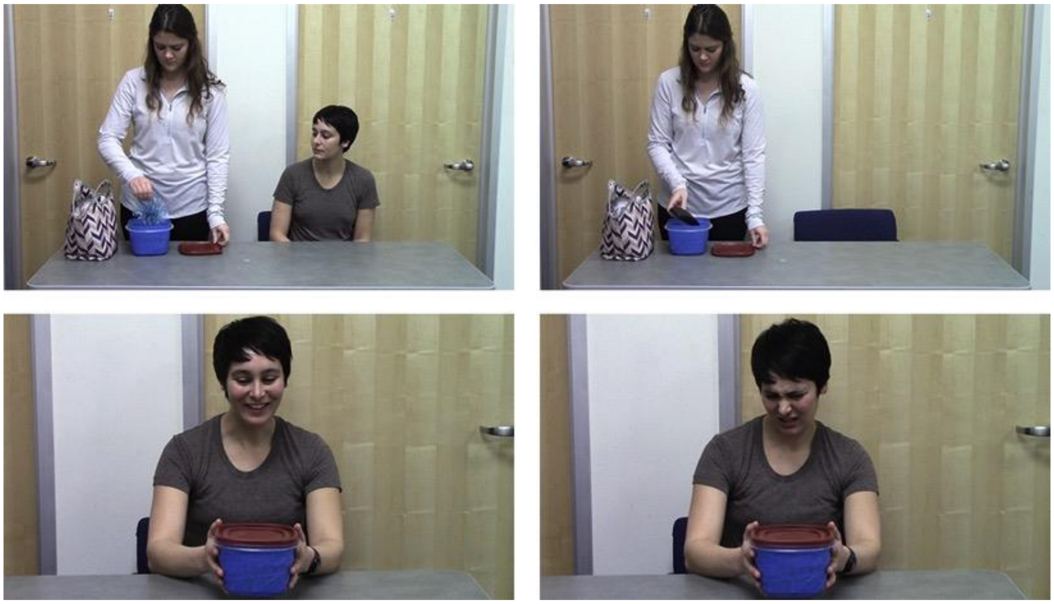


Figure 6. Events presented in the test trials of the false-belief condition in Experiment 3. The object (desirable, undesirable) in the container at the end of each trial was counterbalanced.

Design

Infants were randomly assigned to one of four conditions and viewed both the excited and disappointed test trials within condition (see Table 3). The order of test trials was counterbalanced. It was predicted that infants would look longer at incongruent responses regardless of belief or final object.

Table 3

List of conditions in Experiment 3 organized by experimenter belief and final object in box

	Final Object	
Belief	Undesirable	Desirable
False	**Excited**/Disappointed	Excited/**Disappointed**
True	Excited/**Disappointed**	**Excited**/Disappointed

Note: Congruent emotional reactions are bolded.

Apparatus and Procedure

Infants sat on their caregiver's lap at a table 0.5 m in front of a high definition television monitor (122 cm x 68.5 cm). Caregivers were instructed to remain neutral and refrain from interacting with the infant. A camcorder centered 20 cm beneath the television monitor recorded the infants' looking behaviors. A second camcorder placed in the corner of the room 1 m behind the infant at a height of 1.2 m captured a view of the television screen and was used to verify that the stimuli displayed correctly.

Each experiment began with an attention-getting image of a tree (22 cm x 28 cm) displayed on the screen while the caregiver and infant took their seats at the table. Once the caregiver and infant were situated, the technician pressed the keyboard to begin the experiment. All infants viewed a preference trial and two test trials. Each trial consisted of an initial and final phase. The duration of the initial phase was fixed and identical for all participants. The duration of the final phase was infant-controlled and consisted of the paused portions of each trial. A 4-s countdown audiovisual clip was displayed before and after the preference trial as well as after the first test trial to maintain infants' attention towards the screen.

The television was connected to a computer installed with customizable Python software that displayed and regulated the presentation of stimuli (Peirce, 2007). An experimenter viewed a live feed of each infant's looking behavior and activated the computer-controlled pacing of the stimuli by pressing and holding a keyboard button each time the infant attended to the television or releasing the button when the infant looked away. The software used these key presses to calculate looking time duration for the final phase of each trial, which remained paused on the television monitor until the infant either (1) looked away for at least 2 consecutive s after having looked for at least 1 s or (2) looked cumulatively for 60 s (preference trial) or 90 s (test trials).

Coding

Two coders naïve to the hypotheses and conditions of the study viewed all trials frame-by-frame to code whether each infant looked or did not look at the monitor. The coders agreed on an average of 95% of coded video frames. The trials of infants who were prematurely advanced by the online coder were excluded for experimenter error.

Results

Infants' looking time during the test trials was log-transformed to reduce positive skew (see Csibra et al., 2016). The data were analyzed using a repeated-measures mixed effects model specified with a normal distribution, a diagonal link, and a diagonal covariance matrix with final object and belief as between-subjects factors, emotion as a within-subjects factor, and interactions of Final Object × Belief, Final Object × Emotion, Belief × Emotion, and Final Object × Belief × Emotion. Infants' looking time to the preference trial was included as a covariate to account for individual differences in infants' attentiveness. The model used Restricted maximum likelihood (REML) and Satterthwaite approximation of degrees of freedom to account for unequal cell sizes across conditions (Wilcox, 1987). Preliminary analyses revealed no significant interactions of trial order with belief, final object, or emotion (all *F*s < 2.14, *p*s > .15). However, trial order was maintained in the model to account for unbalanced counterbalancing across conditions (see Table 4), but was not explored further.

Table 4

Number of infants per condition in Experiment 3

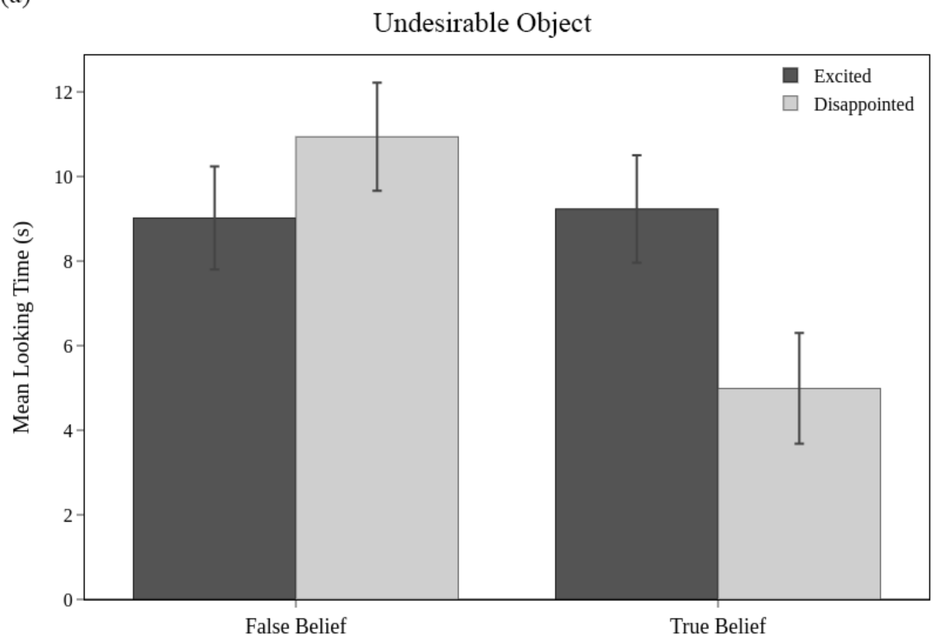
Final Object	Belief	Emotion	T1	T2	Total
Undesirable	False	Excited	4	4	8
		Disappointed	4	3	7
	True	Excited	3	3	6
		Disappointed	3	3	6
Desirable	False	Excited	2	3	5
		Disappointed	2	2	4
	True	Excited	3	3	6
		Disappointed	3	3	6

Note: ‘T1’ = First test trial. ‘T2’ = Second test trial.

There were no significant effects of final object, belief, or emotion, (all *F*s < .70, all *p*s > .41). The interactions of Final Object × Belief, Final Object × Emotion, and Final Object × Belief × Emotion were also not significant (all *F*s < 1.56, all *p*s > .22). However, the Belief × Emotion interaction was just shy of statistical significance, $F(1, 33) = 4.00$, $p = .054$, $\eta_p^2 = .11$, and was thus explored further.

Post hoc comparisons collapsing across final object revealed that infants in the false belief condition looked longer at disappointed trials (*M* = 10.92 s) than excited trials (*M* = 9.43 s), though this difference was not statistically significant, $F(1, 21) = 1.71$, $p = .21$, $d = 56$. Conversely, infants in the true belief condition looked longer at excited trials (*M* = 9.76 s) than disappointed trials (*M* = 6.73 s), though this difference was also not significant, $F(1, 21) = 1.87$, $p = .19$, $d = .58$. To further explore the looking pattern of the Belief × Emotion interaction, the data were split by final object condition, revealing a replication of the pattern in both object conditions (see Figure 7).

(a)



(b)

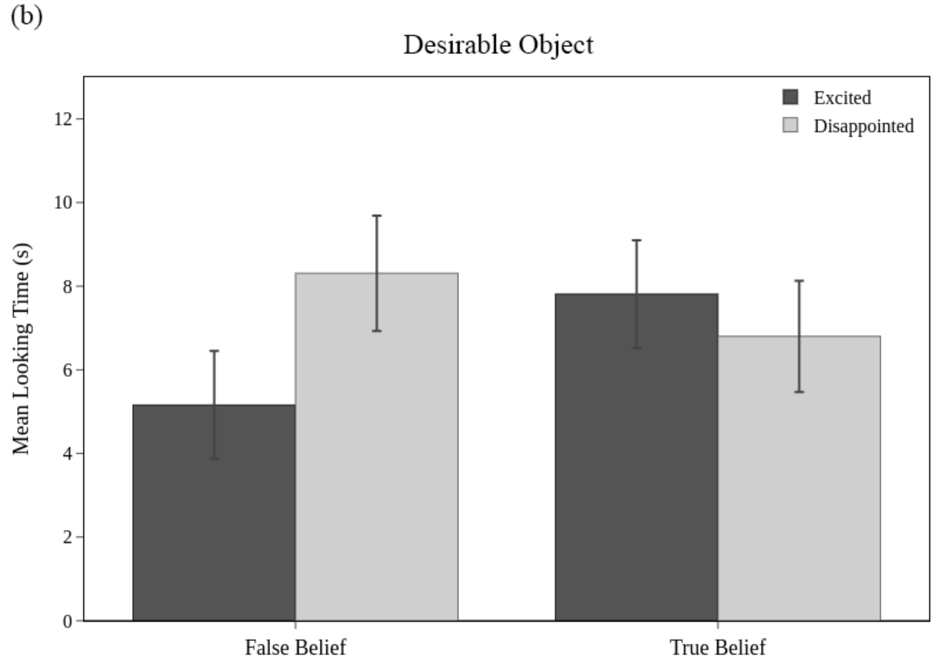


Figure 7. Results of the Belief × Emotion from Experiment 3 separated by undesirable (a) and desirable (b) objects. Estimated Marginal Means of infant looking time to Excited and Disappointed reactions as a function of belief. Error bars represent *SD*s.

Discussion

This is the first study to examine infants' false-emotion attributions. Though the study had some limitations, these findings contribute to the growing literature on infants' appreciation of belief-based emotions. Contrary to predictions, infants did not look reliably longer at incongruent emotional reactions in any condition. Specifically, infants who observed an experimenter respond emotionally to a box containing a desirable or undesirable object did not differentiate between excited and disappointed reactions, regardless of the experimenter's belief. Notably, however, a trending pattern emerged suggesting that infants may have made false-emotion attributions. Specifically, infants looked longer when the experimenter held a false belief about the box's contents and expressed disappointment rather than excitement. Conversely, infants looked longer when the experimenter knew the true contents of the box and expressed excitement rather than disappointment. Both patterns held regardless of which object was in the box.

These looking patterns suggest that infants were able to make false-emotion attributions but were not sensitive to the experimenter's object preference. Specifically, infants appeared to view the object initially placed in the box, whether it was the ball (i.e., the hypothesized desirable object) or rectangle (i.e., the hypothesized undesirable object), as desirable and the object placed in the box after the switch as undesirable. Infants then appeared to make false-emotion attributions toward the experimenter based on this stance. Previous research has shown that 18-month-old infants are able to account for others' preferences, even if they differ from their own (Repacholi & Gopnik, 1997). However, the current results suggest that 20-month-old infants are not able to simultaneously account for others' preferences while making emotion attributions regarding switched objects, though, this interpretation merits caution given the lack of statistical support.

The results are also difficult to interpret when separated by final object. When applied to only the undesirable object condition, the results are in line with previous research demonstrating that 18-month-old infants expected an agent to express negative affect rather than positive affect after experiencing a negative event and vice versa if the agent responded to a positive event (Chiarella & Poulin-Dubois, 2013; see also Reschke, Walle, Flom, & Guenther, 2017). However, this interpretation does not hold when applied to the findings of the undesirable object condition, which resulted in a reversal in the looking pattern: Infants looked longer at hypothesized congruent responses to positive and negative events as opposed to incongruent responses. Similar statistically unsupported patterns have been demonstrated by 8- (Skerry & Spelke, 2014) and 15-month-old infants (Chiarella & Poulin-Dubois, 2013) who looked longer or engaged in more hypothesis testing (i.e., back-and-forth looking behavior) to an agent's positive rather than negative emotional reaction to a positive event. Taken together, additional research is needed with an increased number of infants to confirm the observed patterns.

Several limitations exist in the present study that may explain the ambiguity of the results. First, the small sample size resulted in an unevenly distributed age range of infants across conditions. For instance, some conditions had as few as 4 infants due to missing trials or had a mean age ranging from 19.07 months to 20.85 months, indicating that there was inconsistent heterogeneity across and within conditions. Additional research with a larger sample and a less variable age range is needed to bolster the findings.

Second, infants may have struggled to make clear emotion attributions to an agent responding to a contained object. Although previous research has shown that 18-month-old infants can relate other's positive and negative emotional expressions to the contents of boxes (Repacholi, 1998), research has yet to investigate whether infants at this age can also make emotion attributions regarding an agent's reaction to a contained object. Additional investigations addressing this specific question may be necessary to establish the plausibility of this study's paradigm and better understand the current results.

Lastly, it is also possible that the targeted age in this study underestimated the likely emergence of false-emotion attributions. Previous research using verbal elicited-response measures has demonstrated a developmental lag in children's false-emotion attributions relative to their emotion attributions based on true belief (Bradmetz & Schneider, 2004; see also Harris et al., 1989). It is conceivable that a similar lag exists for this skill when assessed using nonverbal spontaneous-response measures. Thus, future research on infant false-emotion attributions must account for this possibility.

Chapter 5

Recent advances in the development of emotion understanding (e.g., Repacholi et al., 2014, Skerry & Spelke, 2014) and social cognition (Scott, 2017; Knudsen & Liszkowski, 2013; Hoicka & Gattis, 2008) suggest that these two processes are developmentally interconnected (Reschke, Walle, & Dukes, 2017). The above collection of experiments examined three areas of social cognition in which emotion understanding may play a fundamental role: action understanding, goal understanding, and belief understanding. Collectively, the results from these experiments provide evidence that infants make sense of others' behaviors by making attributions regarding their emotional states, goal states, and belief states. Below I summarize and discuss the findings for each experiment in relation to the aims of this program of research and then consider future directions for this research program as a whole.

Chapter 2 presented findings from a study investigating infants' ability to use others' actions to predict their emotions (Reschke, Walle, Flom, & Guenther, 2017). Infants observed an emoter engage in a situation with a social partner in which the emoter was either given a toy, had her toy broken, or fought with another individual over a toy. Analyses of infants' looking patterns indicated that infants expected the emoter to express joy in response to being given a toy and to express anger or sadness in response to having fought over a toy. However, infants did not exhibit clear emotional expectations when the toy was broken by the social partner.

The results of Chapter 2 facilitate comparison with prior research using similar methodologies (Skerry & Spelke, 2014) and provide the earliest evidence that infants can attribute negative emotions to others' negative action outcomes. Previous research has indicated that 10-month-old infants make positive emotion attributions but fail to expect others to respond with negative affect to negative events (Skerry & Spelke, 2014). Taken together, infants appear to be able to make positive emotion attributions at 10 months of age but do not make negative emotion attributions until 12 months of age. This developmental lag might be due to infants' emerging understanding of failed actions (Brandone & Wellman, 2009) or increased experience becoming the target of a caregiver's negative emotion across this (Biringen et al., 1995). Longitudinal research assessing infants' emotion attribution across multiple time points as well as interventions designed to diversify infants' own emotional experiences can advance our understanding of the mechanisms contributing to this developmental gap.

In Chapter 3, I presented a study examining infants' ability to use others' emotions to infer and imitate their failed intentions. Fifteen- and 18-month-old infants observed an experimenter attempt but fail three times to complete a target action on a novel object. After each failed attempt, the experimenter expressed frustration or neutral affect. Infants were then given the opportunity to interact with the object. Analysis of infants' reenactment of the intended action (i.e., the action *not* observed by the infant) revealed that both age groups imitated some target actions, regardless of which emotion they observed. However, 18-month-old infants, but not 15-month-olds, reenacted more target actions in the frustration condition than the neutral condition.

The results of Chapter 3 provide the first evidence that the ability to use others' emotions to disambiguate and imitate others' unobserved failed actions emerges at 18 months of age. This novel contribution demonstrates that 18-month-old infants not only appreciate others' emotional expressions but are able to relate such expressions to their underlying goals to make sense of others' behaviors. Fifteen-month-old infants, on the other hand, may have failed to demonstrate the observed pattern because of underdeveloped coordination between these two abilities. Additional research implementing a positive reaction after the experimenter's "failed attempt" would further address the development of emotion-enhanced imitation.

Chapter 4 presents the results of a study examining infants' ability to make false-emotion attributions. Twenty-month-old infants observed an experimenter express an emotion congruent or incongruent with the belief (true or false) that a lidded, opaque box contained a desirable or undesirable object. Analyses of infants' looking patterns revealed no clear evidence that infants exhibited emotional expectations of any kind, regardless of belief, the object in the box, or the emotion expressed.

Although the results revealed no significant effects, one pattern emerged worthy of mention, but its interpretation deserves caution. First, infants appeared to treat whichever object was initially placed in the container as desirable and whichever object was later placed in the container as undesirable. At test, infants then expected the experimenter to express excitement if she was absent for the object switch but expected her to express disappointment is she was aware of the switch. This pattern suggests that infants were able to account for the experimenter's belief state when making emotion attributions, but were unable to modify such attributions based on the hypothesized preferential qualities of the objects. If this pattern holds with additional testing, the findings would provide the first evidence that infants can make false-emotion attributions.

This program of research has at least two limitations, one practical and the other conceptual. First, the present studies examining infants' understanding of emotions and actions, goals, and false beliefs represent only some areas in which more careful consideration of emotion understanding can be beneficial. One additional area is that of prosocial responding, which involves interpreting others' needs and emotions and coordinating a helpful response (Dunfield, 2014; Dunfield & Kuhlmeier, 2013). For example, infants may rely on others' emotional dispositions to identify victims and beneficiaries of destructive or helpful behaviors. In the study by Vaish and colleagues (Vaish, Carpenter, & Tomasello, 2009), 18- and 25-month-olds observed an experimenter admire and express positive affect toward several objects (e.g., a picture, a necklace). Subsequently, infants witnessed an aggressor steal and destroy the experimenter's objects (harm condition) or a second set of objects (neutral condition). Infants were significantly more likely to respond prosocially toward the experimenter in the harm condition than in the neutral condition, even though the experimenter did not express distress overtly in either scenario. It is possible that infants' prosocial responses resulted from appreciating the experimenter's previously expressed positive relation with the objects and the aggressor's subsequent disruption of that relation. Thus, visible distress by the experimenter was not necessary for infants at this age to infer her emotional state given the context (though such affective expressions might be necessary for younger infants). Conversely, had the experimenter expressed negative affect (e.g., disdain) toward the objects prior to the aggressor's actions, infants may have interpreted the aggressor's destruction as helpful, if not nonthreatening, and been less likely to subsequently behave prosocially.

Recent research has also examined more explicitly the role of affective cues (i.e., sadness versus neutral) in eliciting infants' instrumental helping (Newton, Goodman, & Thompson, 2014). Overall, infants responded with equal amounts of instrumental helping, regardless of which affective expressions were observed, suggesting that instrumental cues (e.g., reaching motions) alone were sufficient to motivate infants' prosocial behavior. Although these findings could suggest that affect does not play a meaningful role in encouraging infants' instrumental helping (see Hepach, Vaish, Grossman, & Tomasello, 2016), this interpretation depends on how emotional information is operationalized in the study. Specifically, the neutral condition, in which the experimenter expressed mild surprise and confusion, is laden with emotional information that infants likely used to evaluate the relational significance of the context. Thus, it is difficult to rule out whether the null effect of emotion in this paradigm actually indicates that both expressions (i.e., sadness and surprise) effectively communicated instrumental need and prompted infants' helping behavior.

At the conceptual level, although these experiments demonstrate that emotion understanding and social cognition are interconnected developmentally, they do not explain *how* they are connected. Research investigating potential developmental mechanisms is needed to more fully understand infant social, cognitive, and emotional development, and whether the addition of emotional cues facilitates or complicates infants' understanding of others' behaviors. For instance, infants' own experiences with frustrated goals may be related to their ability to identify and imitate others' frustrated intentions, but infants may struggle early in development to incorporate multiple cognitive and emotional cues to make sense of others' behaviors. However, research using verbal elicited-response measures has documented the facilitative influence of parental mental-state language in the emergence of theory of mind, including false-emotion attributions (de Rosnay, Pons, Harris, & Morrell, 2004; see also Lagattuta & Wellman, 2002). Studies with older children have also shown that deficits in executive functioning are related to deficits in social cognition and emotion understanding (Hughes, Dunn, & White, 1998). Lastly, research has highlighted the importance of examining the development of theory of mind through a cultural lens to better understand cross-cultural differences in the emergence of emotion understanding and social cognition (Vinden, 1999).

In this dissertation, I presented findings that contribute to a growing literature examining the co-development of emotion understanding and social cognition. These studies explicitly examined the connection between infants' understanding of actions, goals, and beliefs with infants' emotion understanding. The results of these experiments suggest that infants are able to attribute a variety of mental states to others, including emotional, motivational, and counterfactual states, and that the coordination of these attributions matures with age. Future work in the areas of emotion understanding and social cognition that further acknowledges and examines the interconnected nature of these processes will greatly enhance our understanding of the origins of human social and emotional development.

References

Bahrick, L. E., & Lickliter, R. (2000). Intersensory redundancy guides attentional selectivity and perceptual learning in infancy. *Developmental Psychology*, *36*, 190-201.

Baillargeon, R., Scott, R. M., & Bian, L. (2016). Psychological reasoning in infancy. *Annual Review of Psychology*, *67*, 159-186.

Baillargeon, R., Scott, R. M., & He, Z. (2010). False-belief understanding in infants. *Trends in Cognitive Sciences*, *14*, 110-118.

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

Barna, J., & Legerstee, M. (2005). Nine-and twelve-month-old infants relate emotions to people's actions. *Cognition & Emotion*, *19*, 53-67.

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.

Behne, T., Carpenter, M., Call, J., & Tomasello, M. (2005). Unwilling versus unable: infants' understanding of intentional action. *Developmental Psychology*, *41*, 328-337.

Bellagamba, F., Camaioni, L., & Colonnesi, C. (2006). Change in children's understanding of others' intentional actions. *Developmental Science*, *9*, 182-188.

Bellagamba, F., & Tomasello, M. (1999). Re-enacting intended acts: Comparing 12-and 18-month-olds. *Infant Behavior and Development*, *22*, 277-282.

Biringen, Z., Emde, R. N., Campos, J. J., & Appelbaum, M. I. (1995). Affective reorganization in the infant, the mother, and the dyad: The role of upright locomotion and its timing. *Child Development*, *66*, 499-514.

Boccia, M., & Campos, J. J. (1989). Maternal emotional signals, social referencing, and infants' reactions to strangers. *New Directions for Child and Adolescent Development*, *1989*, 25-49.

Bradmetz, J., & Schneider, R. (2004). The role of the counterfactually satisfied desire in the lag between false-belief and false-emotion attributions in children aged 4–7. *British Journal of Developmental Psychology*, *22*, 185-196.

Bradmetz, J., & Schneider, R. (1999). Is Little Red Riding Hood afraid of her grandmother? Cognitive vs. emotional response to a false belief. *British Journal of Developmental Psychology*, *17*, 501-514.

Brandone, A. C., Horwitz, S. R., Aslin, R. N., & Wellman, H. M. (2014). Infants' goal anticipation during failed and successful reaching actions. *Developmental Science*, *17*, 23-34.

Brandone, A. C., & Wellman, H. M. (2009). You can't always get what you want: Infants understand failed goal-directed actions. *Psychological Science*, *20*, 85-91.

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the right thing: Infants' selection of actions to imitate from observed event sequences. *Child Development*, *78*, 806-824.

Buttelmann, D., Carpenter, M., & Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition*, *112*, 337-342.

Campos, J. J., Mumme, D. L., Kermoian, R., & Campos, R. G. (1994). A functionalist perspective on the nature of emotion. *Monographs of the Society for Research in Child Development*, *59*, 284-303.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen-through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development*, *21*, 315-330.

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve-and 18-month-olds copy actions in terms of goals. *Developmental Science*, *8*, F13-F20.

Chiarella, S. S., & Poulin-Dubois, D. (2013). Cry babies and Pollyannas: Infants can detect unjustified emotional reactions. *Infancy*, *18*, E81-E96.

Chiarella, S. S., & Poulin-Dubois, D. (2015). "Aren't you supposed to be sad?" Infants do not treat a stoic person as an unreliable emoter. *Infant Behavior and Development*, *38*, 57–66.

Chiarella, S. S., & Poulin-Dubois, D. (2018). "Are you really sad?" Infants show selectivity in their behaviors toward an unconventional emoter. *Infancy*, *23*, 453-470.

Csibra, G., Hernik, M., Mascaro, O., Tatone, D., & Lengyel, M. (2016). Statistical treatment of looking-time data. *Developmental Psychology*, *52*, 521-536.

De Rosnay, M., Pons, F., Harris, P. L., & Morrell, J. (2004). A lag between understanding false belief and emotion attribution in young children: Relationships with linguistic ability and mothers' mental-state language. *British Journal of Developmental Psychology*, *22*, 197-218.

Dunfield, K. A. (2014). A construct divided: prosocial behavior as helping, sharing, and comforting subtypes. *Frontiers in Psychology*, *5*, 958.

Dunfield, K. A., & Kuhlmeier, V. A. (2013). Classifying prosocial behavior: Children's responses to instrumental need, emotional distress, and material desire. *Child Development*, *84*, 1766-1776.

Flom, R., & Bahrick, L. E. (2007). The development of infant discrimination of affect in multimodal and unimodal stimulation: The role of intersensory redundancy. *Developmental Psychology*, *43*, 238-252.

Freeman, W. J. (2000). Emotion is essential to all intentional behaviours. In M. D. Lewis & I. Granic (Eds.), *Emotion, development and self-organization: Dynamic systems approaches to emotional development* (pp. 209–235). New York: Cambridge University Press.

Gnepp, J., McKee, E., & Domanic, J. A. (1987). Children's use of situational information to infer emotion: Understanding emotionally equivocal situations. *Developmental Psychology*, *23*, 114-123.

Hamlin, J. K., Newman, G. E., & Wynn, K. (2009). Eight-month-old infants infer unfulfilled goals, despite ambiguous physical evidence. *Infancy, 14*, 579–590.

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

Hepach, R., & Westermann, G. (2013). Infants' sensitivity to the congruence of others' emotions and actions. *Journal of Experimental Child Psychology*, *115*, 16-29.

Hepach, R., Vaish, A., Grossmann, T., & Tomasello, M. (2016). Young children want to see others get the help they need. *Child Development*, *87*, 1703-1714.

Hernik, M., & Southgate, V. (2012). Nine-months-old infants do not need to know what the agent prefers in order to reason about its goals: On the role of preference and persistence in infants' goal-attribution. *Developmental Science*, *15*, 714-722.

Hoicka, E., & Gattis, M. (2008). Do the wrong thing: How toddlers tell a joke from a mistake. *Cognitive Development*, *23,* 180-190.

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: Uneven understanding of mind and emotion and executive dysfunction in "hard-to-manage" preschoolers. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *39*, 981-994.

Johnson, S. C., Booth, A., & O'Hearn, K. (2001). Inferring the goals of a nonhuman agent. *Cognitive Development*, *16*, 637-656.

Knudsen, B., & Liszkowski, U. (2013). One-year-olds warn others about negative action outcomes. *Journal of Cognition and Development*, *14*, 424-436.

Király, I. (2009). The effect of the model's presence and of negative evidence on infants' selective imitation. *Journal of Experimental Child Psychology*, *102*, 14-25.

Kovács, Á. M., Téglás, E., & Endress, A. D. (2010). The social sense: Susceptibility to others' beliefs in human infants and adults. *Science*, *330,* 1830-1834.

Lagattuta, K. H., & Wellman, H. M. (2002). Differences in early parent-child conversations about negative versus positive emotions: Implications for the development of psychological understanding. *Developmental Psychology*, *38*, 564-580.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 159-174.

Lang A. (Ed.). (1889). The blue fairy book (Vol. 1). London: Longmans, Green, and Company.

Lazarus, R. S. (1991). *Emotion & adaptation*. New York, NY: Oxford University Press.

Legerstee, M., & Markova, G. (2008). Variations in 10-month-old infant imitation of people and things. *Infant Behavior and Development*, *31*, 81-91.

Meltzoff, A. N. (1985). Immediate and deferred imitation in fourteen-and twenty-four-month-old infants. *Child Development*, 62-72.

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

Meltzoff, A. N., Gopnik, A., & Repacholi, B. M. (1999). Toddlers' understanding of intentions, desires, and emotions: Explorations of the dark ages. In P. D. Zelazo, J. W. Astington, & D. R. Olson (Eds.), *Developing theories of intention: Social understanding and self-control* (pp. 17–41). Mahwah, NJ: Erlbaum.

Moll, H., Kane, S., & McGowan, L. (2016). Three-year-olds express suspense when an agent approaches a scene with a false belief. *Developmental Science, 19*, 208-220.

Moll, H., Khalulyan, A., & Moffett, L. (2017). 2.5-year-olds express suspense when others approach reality with false expectations. *Child Development, 88*, 114–122.

Newton, E. K., Goodman, M., & Thompson, R. A. (2014). Why do some toddlers help a stranger? Origins of individual differences in prosocial behavior. *Infancy*, *19*, 214-226.

Nielsen, M. (2009). 12-month-olds produce others' intended but unfulfilled acts. *Infancy*, *14*, 377-389.

Olineck, K. M., & Poulin-Dubois, D. (2009). Infants' understanding of intention from 10 to 14 months: Interrelations among violation of expectancy and imitation tasks. *Infant Behavior and Development*, *32*, 404-415.

Peirce, J. W. (2007). PsychoPy—Psychophysics software in Python. *Journal of Neuroscience Methods*, *162*, 8-13.

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.

Premack, D., & Premack, A.J. (1994). Moral belief: form versus content. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 149–168). New York: Cambridge University Press.

Repacholi, B. M. (1998). Infants' use of attentional cues to identify the referent of another person's emotional expression. *Developmental Psychology*, *34*, 1017-1025.

Repacholi, B. M. (2009). Linking actions and emotions: Evidence from 15-and 18-month-old infants. *British Journal of Developmental Psychology*, *27*, 649-667.

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

Repacholi, B. M., Meltzoff, A. N., & Olsen, B. (2008). Infants' understanding of the link between visual perception and emotion: "If she can't see me doing it, she won't get angry". *Developmental Psychology*, *44*, 561-574.

Repacholi, B. M., Meltzoff, A. N., Rowe, H., & Toub, T. S. (2014). Infant, control thyself: Infants' integration of multiple social cues to regulate their imitative behavior. *Cognitive Development*, *32*, 46-57.

Reschke, P. J., Walle, E. A., Flom, R., & Guenther, D. (2017). Twelve-month-old infants' sensitivity to others' emotions following positive and negative events. *Infancy*, *22*, 874-881.

Reschke, P. J., Walle, E. A., & Dukes, D. (2017). Interpersonal development in infancy: The interconnectedness of emotion understanding and social cognition. *Child Development Perspectives*, *11*, 178-183.

Russell, J. A., & Bullock, M. (1985). Multidimensional scaling of emotional facial expressions: similarity from preschoolers to adults. *Journal of Personality and Social Psychology*, *48*, 1290-1298.

Saarni, C. (1999). *The development of emotional competence*. New York, NY: Guilford Press.

Saarni, C., Campos, J. J., Camras, L. A., & Witherington, D. (2006). Emotional development: Action, communication, and understanding (2006). In Eisenberg, N., Damon, W., & Lerner, R. M. (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (Vol. 3, pp. 226-299). Hoboken, NJ: John Wiley & Sons.

Sakkalou, E., & Gattis, M. (2012). Infants infer intentions from prosody. *Cognitive Development*, *27*, 1-16.

Scott, R. M. (2017). Surprise! 20-month-old infants understand the emotional consequences of false beliefs. *Cognition*, *159*, 33-47.

Skerry, A. E., & Spelke, E. S. (2014). Preverbal infants identify emotional reactions that are incongruent with goal outcomes. *Cognition*, *130*, 204-216.

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

Striano, T., & Vaish, A. (2006). Seven-to 9-month-old infants use facial expressions to interpret others' actions. *British Journal of Developmental Psychology*, *24*, 753-760.

Southgate, V., & Vernetti, A. (2014). Belief-based action prediction in preverbal infants. *Cognition*, *130*, 1-10.

Thompson, R. A. (1987). Development of children's inferences of the emotions of others. *Developmental Psychology*, *23*, 124-131.

Vaish, A., Carpenter, M., & Tomasello, M. (2009). Sympathy through affective perspective taking and its relation to prosocial behavior in toddlers. *Developmental Psychology*, *45*, 534-543.

Vaish, A., & Woodward, A. (2010). Infants use attention but not emotions to predict others' actions. *Infant Behavior and Development*, *33*, 79-87.

Vinden, P. G. (1999). Children's understanding of mind and emotion: A multi-culture study. *Cognition & Emotion*, *13*, 19-48.

Walker-Andrews, A. S. (1997). Infants' perception of expressive behaviors: Differentiation of multimodal information. *Psychological Bulletin*, *121*, 437-456.

Walle, E. A., & Campos, J. J. (2012). Interpersonal responding to discrete emotions: A functionalist approach to the development of affect specificity. *Emotion Review*, *4*, 413-422.

Walle, E. A., Reschke, P. J., & Knothe, J. M. (2017). Social referencing: Defining and delineating a basic process of emotion. *Emotion Review*, *9*, 245-252.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: the truth about false belief. *Child Development*, *72*, 655-684.

Wilcox, R. R. (1987). New designs in analysis of variance. *Annual Review of Psychology*, *38*, 29–60.

Woodward, A. L. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition*, *69*, 1-34.

Yott, J., & Poulin-Dubois, D. (2012). Breaking the rules: Do infants have a true understanding of false belief?. *British Journal of Developmental Psychology*, *30*, 156-171.