

## REPORT

# Infant social attention predicts preschool social cognition

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### Abstract

*Recent research examining infants' understanding of intentional action claims to be studying the early origins or precursors of children's later theories of mind. If these infant understandings are continuous with later preschool achievements, there should be empirical connections between the two. We provide initial evidence that infants' social attention predicts later social cognition. Specifically, 14-month-olds' habituation to human intentional action significantly predicts later preschool mentalistic construal of persons, as measured on a Theory of Mind Scale.*

### Introduction

Adults largely understand people in intentional, mentalistic terms. They see people as having intentional mental states – e.g. beliefs *about* the world, desires *for* things – and they construe actions as intended – directed toward desired goals. Over the past 10 years researchers have traced the beginnings of this intentional understanding to preschoolers and toddlers and, perhaps, even to its beginnings in infancy. Preschoolers share with adults an intentional, mentalistic construal, or ‘theory of mind’ (Flavell & Miller, 1998; Wellman & Gelman, 1998) in that they employ a variety of mental-state constructs to reason about persons’ actions, their beliefs, desires, false beliefs, intentions (e.g. Gopnik & Slaughter, 1991); they conversationally describe and explain human behavior in terms of what the person ‘wants’, ‘thinks’ and ‘knows’ (e.g. Dunn, 1995); they distinguish intended voluntary actions from unintended biological or physical movements such as a person shaking with fever or being blown down by the wind (e.g. Inagaki & Hatano, 1993; Schult & Wellman, 1997). Even toddlers understand emotions and desires as internal and subjective (e.g. Repacholi & Gopnik, 1997; Bartsch & Wellman, 1995) and understand action and speech as guided by the person’s intentions (Meltzoff, 1995; Carpenter, Aktar & Tomasello, 1998).

What are the origins of this preschool theory of mind in infancy? Infant understanding of persons is a classic

issue, one tackled in traditional research using such methods as still-face, social referencing, and joint attention paradigms. For example, around 9 to 14 months infants begin to show success at following others’ visual gaze (Butterworth, 1991; Scaife & Bruner, 1975), act positively versus hesitantly toward objects depending on the emotion displayed by someone else (Feinman, 1982; Sorce, Emde, Campos & Klinert 1985), and even earlier in life become upset when people do not behave actively and contingently (Muir & Haines, 1993). These social accomplishments clearly demonstrate that other people influence the infant in increasingly complex ways. It is unclear, however, what these accomplishments require in terms of an understanding of the other person (see reviews by Baldwin & Moses, 1996; Moore & Corkum, 1994).

To help address these ambiguities, in the last several years investigators have turned to preferential looking methods to further examine infants’ understanding of persons and their emotions and actions. For example, Phillips, Wellman and Spelke (2002) examined whether and when infants understand that a person looking positively at an object is likely to want it and so reach for it. In this research infants saw a person look at one of two objects with an expression of interest and joy. After familiarization to multiple trials of such a display infants saw two test events. In the *consistent* test event the actor first looked positively at one of the two objects and then went on to hold that same object (consistent with an

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understanding that actors' intentional actions are directed by their perceptual-emotional regard). In the *inconsistent* test event the actor first looked positively at one of the two objects but then went on to hold the other (not positively regarded) object. Twelve- and 14-month-olds, but not 8-month-olds, looked longer at the inconsistent test event. This one series of studies is complemented by recent research by Woodward (1998, 1999), by Gergely (Gergely, Nadasdy, Csibra & Biro, 1995; Csibra, Gergely, Biro, Koos & Brockbank, 1999), by Baldwin (Baldwin, Baird, Saylor & Clark, 2001) and others using similar preferential looking methods. In total this research is contributing to a contemporary picture of infants' developing understanding of persons as intentional actors and experiencers.

The extent to which these infant understandings are linked to later preschool achievements, however, is very much an open question. If advances in infant social cognition are early steps in a process that results in the accomplishments of 3- and 4-year-olds, let alone adults, then there could be empirical connections between these earlier and later achievements. We provide preliminary data on such connections. Specifically, we took advantage of having tested a sufficiently large group of 14-month-olds in Phillips *et al.* (2002), to test many of the same children on theory of mind tasks as 4-year-olds. This allowed us to relate infant social cognitive preferential looking to preschoolers' advances in theory of mind understanding, paralleling a tradition of research that demonstrates important continuity between infants' attention to perceptual-object displays and later IQ (see e.g. Bornstein & Sigman, 1986; McCall & Carriger, 1993).

## Methods

### *Participants*

In Study 4 of Phillips *et al.* (2002) 32 14-month-olds participated in that preferential looking task. We were able to re-test 18 of them soon after their fourth birthdays. There were 11 males and seven females whose average age was 13 months-28 days at first testing (range 13-15 to 14-14) and whose average age was 4 years-3 months (51 months) at second testing (10 were tested at 51 months, the others ranged from 50 to 53 months).

### *Tasks*

The *infant task* was briefly described above and is described in detail in Phillips *et al.* (2002). Each infant received four trials of the familiarization scenario then six test trials, three consistent and three inconsistent test

trials in alternating order. For the original sample of 32 infants, on average infants looked significantly longer at the inconsistent test events than at consistent test events, and 24 (75%) looked longer at the inconsistent test events ( $p < .05$ , Sign test). For the 18 infants re-tested at four years, on average these infants looked significantly longer at inconsistent test events, and 13 (72%) looked longer at the inconsistent event ( $p < .05$ , Sign test). Thus, the 18 infants retested as 4-year-olds were very similar to the entire group of 32.

The *4-year-old task* was a battery of five different theory of mind tasks that capture an extended progression of developmental achievements. Specifically, we used a Theory of Mind Scale recently validated by Wellman and Liu (in press). Construction of this scale began with a battery of seven tasks, including two standard false-belief tasks but also tasks assessing children's understandings of desires, knowledge and emotion. In a study of 75 preschoolers, five of these tasks formed a significant Guttman scale such that in the years from 3 to 5 children go from first succeeding on a single task (assessing understanding of desires) to successively succeeding on more and more of the tasks in a strict progression (see Wellman & Liu, 2004, for details). On this battery, a scale score can range from 0 (the child failed all tasks) to 5 (the child passed all five). For the 4-year-olds in the current study, scores ranged from 0 to 5,  $M = 2.9$ .

At 4 years each child also was administered the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) a common, easy-to-administer, measure of preschool verbal intelligence. Since infant habituation (to perceptual-object displays) predicts later verbal IQ and theory of mind performances often correlate with verbal IQ measures, it seemed important to include a measure of preschool verbal intelligence. This would allow assessment of, and a control for, preschool verbal IQ, in order to examine more specific links between infant and preschool *social* cognition. The PPVT has been used in several earlier studies relating infant habituation to later IQ.

### *Habituation measures*

Bornstein and Sigman (1986), among others, note that looking time studies contain two sorts of information for comparing infants – decrements in attention during habituation or familiarization (how much or how quickly the infant habituates to the displays), and recovery from habituation or preference for novelty during test trials. Measures of decrement of attention are straightforward in our infant paradigm. Consider (a) a simple difference score subtracting each infant's looking on their last familiarization trial from their looking on the first. For the 18 infants considered here, that score

averaged 15.2 seconds and ranged from  $-5.8$  to  $65.6$  seconds. Bornstein and Sigman (1986, p. 258) indicate that (b) a decrement of attention score based on subtracting infants' last two familiarization trials from their first two familiarization trials has several advantages. We will term (a) the simple difference score (for decrement of attention) and (b) the alternative difference score. In our data the simple difference score and the alternative difference score correlate highly with each other –  $r(18) = .92$  ( $p < .01$ ).

Novelty preference is less straightforward in our paradigm, at least if we consider earlier research on continuity as a guide, because both of our test displays were novel in comparison to habituation. With this caveat, we were still interested in infants' looking during test trials and infants did look preferentially at the inconsistent versus consistent test events, meaning we could calculate measures of this visual preference. So, consider (c) a simple preference score that subtracts each infant's looking to the inconsistent test events minus their looking to the consistent test events. For these 18 infants, this simple test preference score ranged from  $-2.88$  to  $7.92$  seconds. Bornstein and Sigman (d) suggest a preferred measure for novelty preference (p. 259). This calculation for our case, which we will call the alternative test preference score, would be: looking to inconsistent events divided by looking to the consistent *plus* the inconsistent event. In our data the alternative test preference score correlates highly with the simple test preference score –  $r(18) = .99$  ( $p < .01$ ).

## Results

The key result concerns the relation between infant looking measures and later social cognition (measured by the Theory of Mind Scale). For decrement of attention, infant looking correlated to the Theory of Mind Scale score:  $r(18) = .52$ ,  $p < .05$  for the simple difference score, and  $r(18) = .61$ ,  $p < .01$  for the alternative difference score. For test event looking, infant preferences failed to correlate with the later Theory of Mind Scale scores:  $r(18) = .04$ , ns, for the simple test preference score, and  $r(18) = .07$ , ns, for the alternative test preference score.

We next tested whether the significant correlations could be accounted for by a more general association between decrement of attention and later IQ or verbal language. Infants' decrement of attention to our social displays failed to correlate with PPVT scores at age 4:  $r(17) = .01$  or  $.04$ , ns. (One child of the 18 could not be included in these analyses, because he refused to take the PPVT which came after the theory of mind tasks.) Theory of Mind Scale scores also failed to correlate with

PPVT scores:  $r(17) = .12$ , ns. There was considerable variation on the PPVT (e.g. scores ranged from 94 to 140) so lack of significant correlations was not due to lack of variance. Most importantly, consider the significant correlations reported above for the relation between decrement of attention in infancy and later Theory of Mind scores. These correlations remained significant and undiminished when PPVT scores were partialled out:  $r(17) = .53$ ,  $p < .05$  for the simple difference score, and  $r(17) = .62$ ,  $p < .01$  for the alternative difference score.

Use of the Theory of Mind Scale in the current research seems to have been advantageous. Typically, research correlating theory of mind differences to other factors has used children's false-belief performance alone (e.g. Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991; Lalonde & Chandler, 1995; Astington & Jenkins, 1999). One finding from such studies is that verbal language measures correlate with false-belief judgments. The Theory of Mind scale used here contained a false-belief task. Children's scale score correlates minimally with PPVT, as reported above. The correlation between PPVT and false-belief performance alone was  $r(17) = .23$ , doubling the correlation between PPVT and the full scale. Moreover, as reported, the relation between decrement of attention to later Theory of Mind Scale scores was high ( $.52$ ,  $.61$ ) and significant. The relation of the same infant measures to false-belief performance alone was more modest ( $.37$ ,  $.34$ ) and nonsignificant,  $p > .12$ . These data suggest that the scale may be a more useful (and less language-laden) measure of theory of mind achievements than false-belief performance alone.

## Discussion

A host of studies have confirmed an important continuity between infants' attention to perceptual-object displays and later IQ (Bornstein & Sigman, 1986; McCall & Carriger, 1993). As a shorthand, we will call these the object-attention findings. By taking advantage of a *post hoc* opportunity, we provide an initial social-attention finding: infants' decrement of attention to intentional action displays predicts later social cognition. This finding provides initial support for continuity in early childhood social cognitive processing worthy of replication, clarification and extension.

With regard to replication, initial object-attention findings were based on samples of 18 to 20 children, compared infant measures to 3- and 4-year-old performance, and found correlations ranging around  $.50$  (e.g. Bornstein, 1985; Fagan & McGrath, 1981). Those findings have been replicated and extended in numerous other studies; McCall and Carriger's (1993) meta-analysis

yielded a weighted normalized correlation coefficient for decrement of attention of .41. Our social-attention data parallel the early object-attention data in sample size and magnitude of effect but, of course, require replication in other samples and labs.

That the correlation from infant looking time tasks to later preschool measures in our results was significant only for decrement of attention measures, and not novelty preference, requires clarification in future research. Both sorts of measures correlate to later IQ in object-attention studies, and some might argue that novelty preference should be a more theoretically cogent measure of infant understanding in contrast to speed of familiarization to the habituation display. Perhaps our failure to find significant correlations with our test preference measures is due to the fact that our preference measure did not measure novelty preference, at least not as that has been measured in the object-attention studies. In those prior analyses, novelty preference is measured when, after a familiarization period, the infant's looking to novel over familiar stimuli is assessed. In such studies (e.g. Columbo, Mitchell, O'Brien & Horowitz, 1987; Rose, Feldman & Wallace, 1988) familiar stimuli are identical to those presented in familiarization whereas novel stimuli differ. In contrast, in our infant paradigm (similar to many contemporary studies of infants' object and social cognition, e.g. Spelke, Breinlinger, Macomber & Jacobson, 1992; Woodward, 1998) both consistent and inconsistent test events differ from familiarization, and thus, strictly speaking, are novel. Specifically, in our paradigm during familiarization infants saw only the actor's perceptual-emotional regard; during test trials the actor's perceptual-emotional regard was followed by action (the actor reached for the previously regarded or unregarded object). Perhaps more standard novelty preference measures might show continuity in the social domain as they have in the object-attention literature. This could be addressed in future research by using a strict novelty preference paradigm in a study of infant social attention. It is also the case, however, that our preference scores were less variable than our decrement of attention scores (13 of 18 preferences were in the same direction, and the range of the preference scores was much smaller than the range of the decrement scores). This could be addressed in future research by using babies at a younger and perhaps more transitional age.

Decrement of attention alone, however, can be informative. Decrement of attention as measured during familiarization trials can index infants' ability to parse displays meaningfully and thus habituate to them. Hypothetically, infants who more quickly habituate to complex intentional action displays of the sort we utilize, could

be more practiced at understanding the intentional action regularities packaged in such displays, and thus more quickly become familiarized or bored with them. At the least, our decrement of attention data establish that our methods are sensitive to variation in social cognition across these time periods, and establish an initial empirical association between earlier looking time measures and later theory of mind accomplishments.

Assume we have shown a replicable, significant correlation between infant attention (of some nature) and later theory of mind. How should that association best be interpreted? One possibility is that the continuity we demonstrate simply indexes more general developmental status. Since attention decrement (in object-attention studies) reliably predicts later IQ (including PPVT test performance), perhaps our data simply index differences in global developmental status such that more advanced infants do better on most cognitive tasks later in preschool – IQ, language, perceptual-object cognition *and* social cognition as well. That is, our finding might simply be another demonstration of the finding that infant looking measures predict later IQ or general information processing. Although we cannot completely rule out this alternative, several aspects of our data speak against this interpretation. Infant social attention (as measured in our task) did *not* predict later PPVT performance, and the relation between infant social attention and preschool theory of mind remained undiminished when verbal IQ was partialled out.

A contrasting possibility is that the association we document may be specific to social cognition. That is, perhaps object cognition and social cognition are developmentally dissociated and thus produce distinctively different infant-to-preschool continuities. In this vein note that preschool theory of mind understanding is arguably domain-specific (e.g. Wellman & Gelman, 1998), and also separable from verbal and general IQ. While theory of mind achievements (such as understanding false belief) do correlate significantly with verbal IQ in normal children in the preschool years (e.g. Carlson & Moses, 2001; Happe, 1995), nonetheless theory of mind makes independent contributions to analyses of preschool cognition beyond verbal IQ and beyond other constructs, such as age and executive function performance, which also correlate with IQ (Carlson & Moses, 2001; Happe, 1995). Moreover, individuals with autism have marked deficits in theory of mind understandings even when they have high IQs, whereas theory of mind understandings (and social understanding more generally as well as effective pragmatic use of language) is relatively intact in individuals with Down Syndrome, even though they have below average IQs (Happe, 1995). Thus, it is possible that continuities in the realm of social

cognition could prove separable from continuities in the realm of perceptual-object cognition and IQ.

Our data are consistent with such an interpretation, but clearly do not provide a strong test of that hypothesis. For example, perhaps infant attention in our displays and preschool performance on our tasks is linked to differences in individuals' developing executive function skills. Executive function does correlate with theory of mind (Carlson & Moses, 2001) and executive function developments span infancy and childhood. Our use of the PPVT would not provide a good control for this possible influence of executive processing. Moreover, our data include only measures of infant social attention without contrasting measures of infant object attention. A more comprehensive examination of developmental continuities, therefore, might be to test the same infants on contrasting object- and social-attention tasks and then to test those children on theory of mind, general IQ measures and executive function tasks as well, as preschoolers.

The above proposal, that continuities in the realm of social cognition would prove different from those in the realm of object cognition, is one specific example of the more general possibility that there may be differences in infant processing of social versus physical events. This general possibility motivates our use of the phrases 'social attention' and 'object attention'. These phrases require further clarification. Potentially, social attention might include infant attention to any human stimuli including faces, human voices, static displays of attractive or unattractive individuals, etc. Object attention might in contrast include only attention to physical, nonhuman stimuli such as rocks, abstract shapes or patterns, and non-speech sounds. However, faces and speech sounds, for example, are also physical stimuli in that they present perceivable physical patterns, acoustic events, and so on. Indeed, faces have been used as stimuli in some of the earlier studies that we refer to as object-attention or perceptual-object studies. Arguably, our focus is a very specific sort of social attention, namely infant attention to *intentional* experience and action, as described in our introduction. The current data do not prove that intentional understandings form a distinctive type of 'social attention' in infancy, or that it is these forms of attention and understanding that are specifically related to later theory of mind. Our findings are consistent with such proposals but can only inform and motivate further more definitive research.

In advance of further replications and more comprehensive research paradigms, our results nonetheless offer an exciting new angle on cognitive continuities from infancy to childhood. At the least, they provide initial evidence for an empirical relationship between measures

of attention in late infancy and theory of mind in preschool. In addition, they raise the possibility that infants' early *intentional* understandings may specifically relate to later preschool intentional, mentalistic construals of persons. More importantly, perhaps, this initial study suggests ways to more comprehensively address these possibilities in future research.

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