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PAPER

Infant pointing serves an interrogative function

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Abstract

In recent years there has been a resurgence of interest in the motivations behind, and the function of, infant pointing behaviour. Many studies have converged on the view that early pointing reflects a motivation to share attention and interest with others. Under one view, it is the sharing of attention itself that is the ultimate function of pointing, and is an early manifestation of a uniquely human social cognition that is geared towards cooperation and collaboration. In the current study, we tested an alternative hypothesis in which the goal of pointing is not attention sharing itself, but the information-laden response that infants tend to receive as a result of sharing attention. If infants indeed point in order to obtain information, their pointing should be modulated by the perceived ability of the other to provide this information. In Experiment 1, 16-month-olds who interacted with a demonstrably knowledgeable experimenter pointed significantly more to novel objects than infants who interacted with an ignorant experimenter. In Experiment 2, we confirmed that this finding was due to the perceived competence of the experimenter rather than to the different ways in which the experimenter responded to infants' points. Our results suggest that one function of pointing in infancy is to obtain information from others, and that infants selectively elicit desired information from those whom they perceive could competently provide it.

Introduction

Recent theories have highlighted a number of cognitive biases that human infants appear to possess for ensuring the efficient acquisition of culture (Csibra & Gergely, 2009, 2011). From the innate orienting mechanisms that ensure attention to potential 'teachers' (Farroni, Johnson, Menon, Zulian, Faraguna & Csibra, 2005), to biases to interpret communication in terms of culturally relevant information (Yoon, Johnson & Csibra, 2008; Southgate, Chevallier & Csibra, 2009), there are now many examples of the ways in which infants play an active role in cultural acquisition. The identification of biases to ensure the acquisition of culturally relevant information has also resulted in the reinterpretation of a number of classic infant behaviours within the pedagogy framework (e.g. Southgate *et al.*, 2009; Topal, Gergely, Miklosi, Erdohegyi & Csibra, 2008).

In a recent paper, Southgate, van Maanen and Csibra (2007) hypothesize that another classic infant behaviour, pointing, could also be reinterpreted as a mechanism for cultural transmission. Classically, pointing has been interpreted as either *imperative*, driven by a selfish motive of obtaining something, or *declarative*, with the motivation to share interest with, or to inform, others (Bates, Camaioni & Volterra, 1975; Tomasello, Carpenter & Liszkowski, 2007). However, there are important theoretical reasons to suppose that pointing in early childhood could alternatively, or additionally, serve an *interrogative*, or information-requesting, function. Many studies demonstrate that adults' most common response to infant pointing is to provide labels and information about referents (i.e. Leung & Rheingold, 1981; Hannan, 1992; Kishimoto, Shizawa, Yasuda, Hinobayashi & Minami, 2007). Furthermore, amount of pointing at 10 or 11 months predicts subsequent vocabulary growth (Brooks & Meltzoff, 2008) and it is the referents towards which infants gesture, and for which caregivers provide information in response, that are most likely to enter the child's vocabulary (Goldin-Meadow, Goodrich, Sauer & Iverson, 2007). Caregiver's responses to infant points and their impact on infant knowledge acquisition are strongly compatible with the hypothesis that infants point in order to request and obtain information. If infants indeed point with an interrogative motive, pointing would serve as a powerful cultural learning tool by which infants might elicit and acquire various kinds of information (e.g. demonstrating a function of an object, providing a label or the valence of an object, an explanation of an event, etc.) (Southgate *et al.*, 2007).

If pointing does serve an interrogative function, it follows that it should be influenced by the perceived potential of the recipient to impart knowledge, as long as this potential can be evaluated. Much evidence suggests that infants early in the second year of life indeed have the ability to evaluate the competence of another individual. For example, 16-month-olds appear to understand when a speaker uses an inappropriate label for an

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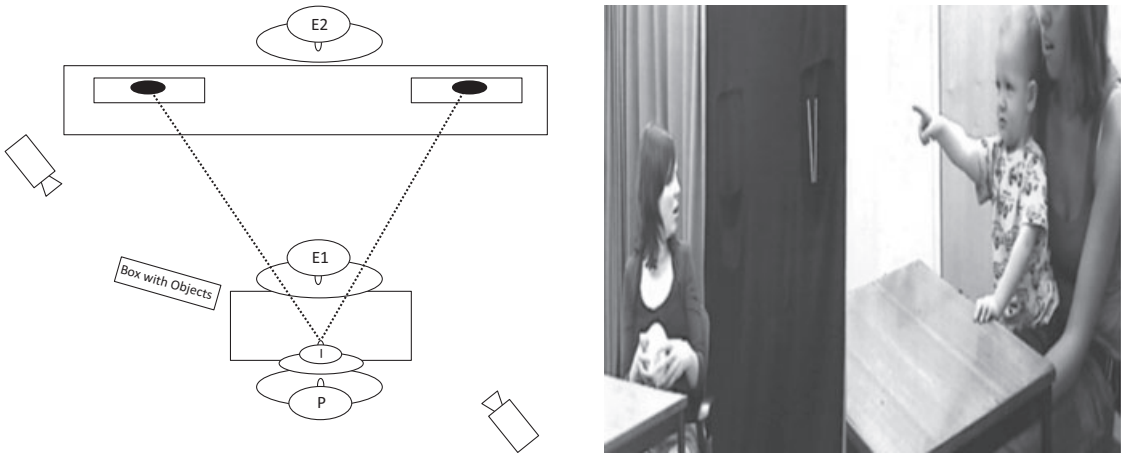

Figure 1 *A schematic representation of the experimental scene (left) and a capture from an experiment recording (right) showing: E1 (left) turning around to face the object the infant (right) is pointing to.*

object (Koenig & Echols, 2003), and 14-month-olds understand when an adult acts competently or incompetently on a familiar object (Zmyj, Buttelmann, Carpenter & Daum, 2010). Importantly, infants do not only detect whether a speaker is knowledgeable, but also use such inferences to guide the kinds of behaviours that would be crucially important for cultural learning, like gaze following (Chow, Poulin-Dubois & Lewis, 2008), and imitation (Zmyj *et al.*, 2010).

In the current study, we explored whether 16-month-olds'[1] pointing to a novel object would be modulated by the perceived potential of the experimenter to provide them with useful information. The perceived knowledge state of the experimenter was established by employing the well-known Trust Paradigm (Lucas & Lewis, 2010). Specifically, infants interacted with an experimenter who either correctly or incorrectly labelled familiar objects (Koenig & Echols, 2003), accompanied by verbal and non-verbal cues to certainty or uncertainty (Jaswal & Malone, 2007; Birch, Frampton & Akmal, 2006). In accord with the hypothesis that pointing serves an information-gathering or *interrogative* function, we predicted that infants would point to novel objects less in the presence of someone they perceive as a potentially unreliable source of information than someone whom they perceive as knowledgeable. In contrast, if infants' motivation for pointing in this study were imperative, or declarative in the sense of sharing interest or excitement, or informing an experimenter of the presence of an object that she cannot see, there would be no clear reason to predict less pointing for the unreliable experimenter since she was responsive, friendly, and demonstrably collaborative in both conditions.

Experiment 1

Participants

Infants were recruited from a database of parents who voluntarily signed up for participating in infant studies. Thirty-four infants (14 female, age 16 months, range 15.1–16.3), with English as their first language, were included in the final sample. An additional 13 infants (eight female) were tested but excluded due to fussiness (five), not having English as a first language (two), parental report of pointing behaviour (four infants were reported to only rarely or never point) and experimental error (two).

Materials and set-up

Infants were seated on their parents' lap, at a table, facing E1. Behind E1, at a distance of 2 m from the infant, there was a large black curtain with two window openings (25 × 25 cm) at a height of 110 cm, separated by 50 cm (15° left and right from infant's midline, both visible to the infant at any moment and for the whole duration of testing, see Figure 1). E2 was hidden behind the curtain, so the infant was not aware of her presence. Eight familiar objects[2] (chosen based on parents' report that infants knew their labels) were stored in a box out of the infants' view and presented individually over the course of two warm-up and six training trials. A further six novel and unfamiliar[3] objects (confirmed to be unfamiliar by the parent) were presented by E2 through the window openings. The entire scene was recorded from two perspectives (see Figure 1).

[1] We chose 16-month-olds because previous research has shown that infants of this age know when a familiar word is inappropriately used (Koenig & Echols, 2003).

[2] The particular objects selected for each child were chosen from the following pool: ball, bottle, book, shoe, duck, banana, telephone, cup, spoon, car, and apple.

[3] Novel objects were chosen as we hypothesized that they would be most likely to elicit interrogative pointing (see Southgate *et al.*, 2007).

Procedure

Infants were randomly assigned to one of two experimental conditions (*Correct Labelling* and *Incorrect Labelling*). Prior to the experiment, only E2 interacted with the infant so as to ensure that infants did not receive mixed signals about the competence/incompetence of E1. Parents were instructed not to interact with the child during testing.

Warm-up phase

An initial warm-up phase involved two trials in which E1 and the infant played together with a familiar object (a different familiar object on each trial). E1 labelled the object three times (either correctly or incorrectly depending on the condition) while holding it out of the infant's reach, and then invited the infant to play with the object and subsequently labelled the object another three times while the infant and E1 interacted with it together. This joint engagement with the object was important to establish the experimenter as cooperative and collaborative in both conditions.

Testing phase

Infants participated in six test trials that were identical to the trials of the warm-up phase except that after the six repetitions of the label had been provided for the familiar object, a novel object appeared through one of the windows behind E1, out of her view. The order of novel objects and the window through which the objects appeared was randomized. E1 signalled (by briefly scratching the back of her head) to E2 when she perceived that the infant had noticed the novel object, in order to ensure that each object was presented for 60 seconds after the infant had first seen it. If the infant pointed to the novel object appearing in the window, E1 turned around, alternated her gaze between the object and the infant and named the object three times. E2 then removed the object from the window and E1 turned back to face the infant and proceeded to the next trial. If the infant did not point to the object within 60 seconds, E2 signalled (by briefly shaking a rattle) that the trial had finished and E1 proceeded to the next trial. The same procedure was repeated on all test trials (six familiar coupled with six novel objects).

Labelling of the familiar objects differed according to the condition. In the *Correct Labelling* condition familiar objects were labelled conventionally (i.e. a book was labelled 'book') in a confident manner (i.e. '*Look [Infant's name]! Look, it's a book!*'). In the *Incorrect Labelling* condition, objects' labels were swapped around among the objects, such that each object received a label of another one of the familiar objects (i.e. a banana was labelled a 'shoe'). The labels were arranged so that the actual and the false label sounded distinctively different (i.e. car was labelled a 'book') and so that none of the objects or labels were ever repeated in a sequence (e.g. a trial in which a telephone was labelled 'apple' was not followed by a trial where either the apple or an object that was labelled a 'telephone' was presented). In addition, when mislabelling the familiar objects, E1 expressed several verbal (i.e. '*Look [Infant's name]! What is this? Hmmm, I think it's a [false label]*') and non-verbal cues (looking puzzled) to uncertainty. We incorporated cues to uncertainty so that infants would interpret the experimenter as unknowledgeable rather than mean or uncooperative since if infants interpreted the experimenter as uncooperative or mean they may not have wished to interact with her, including not pointing for her. Recent research with slightly older children has shown that they are sensitive to such cues (Birch *et al*., 2006). Due to necessary cues to uncertainty in the *Incorrect Labelling* condition, the prosody of the experimenter's speech inevitably differed across conditions; however, the difference was limited to the labelling part of the interaction and otherwise equal in both conditions.

The labels used when naming the novel objects in response to infants' pointing were identical in both conditions but the type of response differed. In the *Correct Labelling* condition, E1 responded by labelling the appearing objects in a confident manner (i.e. '*Oh, look, what's that [Name]? It's a [label]!*'); whereas in the *Incorrect Labelling* condition E1's labelling in response to infant pointing was accompanied by verbal and non-verbal cues to uncertainty (i.e. '*Look [Name]! What is this? Hmmm, I think it's a [label].*'). This difference in response was necessary to ensure that infants received stable information about E1's competence.

Coding and analyses

Data were coded from video recordings of the testing sessions by two independent coders, one of whom was naïve to the experimental hypothesis. Any disagreements were resolved in consultation with a third person. The main measure reported is the proportion of trials in which infants pointed to the novel (target) objects. In accord with Liszkowski and colleagues, a point was defined as an extension of the infant's arm (either fully or slightly bent) and index finger or open hand, palm down, in the general direction of the object (Liszkowski, Carpenter, Striano & Tomasello, 2006). Measures of infants' attention and responsiveness to the experimenter and information on infants' vocabulary and gesture development were also collected.

Results

Non-parametric tests comparing proportion of trials with points across infants in both conditions revealed that infants pointed significantly more in the *Correct Labelling* condition (67%) than in the *Incorrect Labelling* condition (31%) (Mann-Whitney $z = 2.161$, $p = .031$,

two-tailed) (Figure 2). There was no difference in vocabulary scores between children taking part in the two conditions (*vocabulary production* ($t(32) = 0.508$; $p = .615$), *comprehension* ($t(32) = 0.266$; $p = .792$) or *gesture production* ($t(32) = 0.136$; $p = .893$), indicating that the difference in pointing behaviour between conditions cannot be accounted for by variation in infants' verbal or gestural abilities.

For our hypothesis, it is important that infants perceived E1 as unknowledgeable rather than uncooperative or simply mean (Lucas & Lewis, 2010). If infants perceived E1 as uncooperative or mean, they may also have been less inclined to want to interact with her, including through pointing. E1 was demonstrably friendly and cooperative in both conditions. In addition, we tried to ensure that infants in the *Incorrect Labelling* condition perceived E1 as unknowledgeable by emphasizing uncertainty in labelling. Furthermore, we analysed several behaviours that we reasoned should differ between groups if infants indeed perceived the experimenter as uncooperative or mean in the *Incorrect Labelling* condition. We found no effect of condition on any of these measures which included (a) willingness to take objects from the experimenter (no difference in latency to take the object when offered by the experimenter between *Correct* ($M = 1.06$ sec) and *Incorrect Labelling* conditions ($M = 1.41$ sec); $t(32) = 0.840$; $p = .409$), (b) frequency of smiling to the experimenter (*Correct* ($M = 7.35$) and *Incorrect Labelling* condition ($M = 6.53$); Mann-Whitney $z = 1.117$; $p = .264$, two-tailed) or social referencing to a parent (*Correct* ($M = 1.59$) and *Incorrect Labelling* condition ($M = 1.47$); Mann-Whitney $z = 1.239$; $p = .215$, two-tailed). Thus, we found no evidence that infants perceived E1 as someone they did not want to interact with. It is also plausible that infants in the *Incorrect Labelling* condition were confused by the mismatching objects and labels and consequently paid less attention to the novel objects appearing. However, we found no difference in the latency to notice the appearance of the novel object between *Correct* ($M = 9.23$ sec) and *Incorrect Labelling* conditions ($M = 9.49$ sec; $t(32) = 0.99$; $p = .922$).

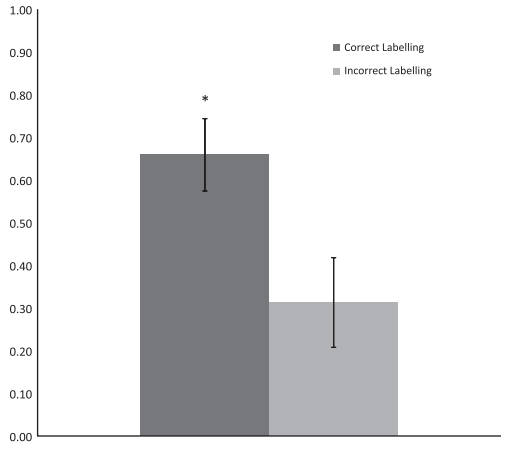

Figure 2 *Proportion of trials with points to target objects across subjects for Correct and Incorrect Labelling conditions. * Indicates a statistically significant difference ($p < .05$).*

Experiment 2

A procedural necessity of Experiment 1 was that, in order to keep E1's perceived knowledge status consistent, the responses that infants received to their points differed between groups. Infants in the *Correct Labelling* condition received certain responses (e.g. '*Look! That's a [label]!*'), whereas infants in the *Incorrect Labelling* condition received uncertain responses (e.g. '*Hmmm, I think that's a [label]!*'). As previous research has suggested that the response that infants received to their points on previous trials may influence the extent to which they continue to point on subsequent trials (e.g. Liszkowski, Carpenter & Tomasello 2007a), the difference in pointing between conditions may have been due *either* to the differences in labelling (correct or incorrect) *or* to the differential response to their points (certain or uncertain). While pointing that is modulated by an uncertain response would also be consistent with an interrogative function, Experiment 2 was designed to clarify which of the two manipulations drove the differences in pointing between conditions. Specifically, in Experiment 2, infants received uncertain responses to their points, but with no prior labelling of familiar objects. If the lesser amount of pointing observed in the *Incorrect Labelling* condition of Experiment 1 is driven by the uncertain response that infants receive to their points, infants in Experiment 2 should point similarly less than infants in the *Correct Labelling* condition of Experiment 1, even if they receive no labels for familiar objects.

Participants

Seventeen infants (nine female, age 16 months, range 15.1–16.3), with English as their first language, were included in Experiment 2. Two additional infants were tested but excluded due to fussiness.

Procedure

The procedure for Experiment 2 was identical to Experiment 1 except that E1 did not provide any labels for the familiar objects. Instead, in the *No Labelling* condition, the same familiar objects were referred to as '*this*' or '*it*' (i.e. '*Look [Infant's name]! Wow, look at this!*'). However, the responses that infants' received to their pointing were identical to those provided in the *Incorrect Labelling* condition of Experiment 1. If the difference in pointing between conditions of Experiment 1 was generated by the infants perceiving the experimenter as unknowledgeable due to her uncertain responding, we should expect infants in Experiment 2 to

also point significantly less than infants in the *Correct Labelling* condition of Experiment 1.

Results

Non-parametric Mann-Whitney tests revealed that the proportion of trials with points to novel objects in the *No Labelling* condition (54%) did not differ significantly from the proportion in the *Correct Labelling* (67%) ($z = 1.050$; $p = .294$, two-tailed) or the *Incorrect Labelling* condition (31%) ($z = 1.601$; $p = .109$). However, rather than decreasing due to uncertain responses, the proportion of infants pointing to unfamiliar objects in the *No Labelling* condition actually increased across trials (Figure 3). Indeed, considering only data from the last three trials, infants pointed significantly more in the *No Labelling* condition of Experiment 2 than in the *Incorrect Labelling* condition of Experiment 1 ($z = 2.090$; $p = .037$, two-tailed), whereas there was no difference between the *No Labelling* condition of Experiment 2 and *Correct Labelling* condition of Experiment 1 ($z = 0.248$; $p = .804$, two-tailed). The fact that infant pointing increased over trials strongly suggests that it was not influenced by the uncertainty of the experimenter's response, and that the difference in pointing between the *Correct* and *Incorrect Labelling* conditions of Experiment 1 was driven by the perception of E1's competence, generated by her correct or incorrect labelling.

Discussion

Although the significance of infant pointing for developing social cognition has been a topic of discussion for many years (e.g. Bates *et al.*, 1975; Camaioni, Perucchini, Bellagamba & Colonnesi, 2004), recent empirical studies have led to a new theory in which early declarative pointing is proposed to reflect infants' motivations to share and cooperate with others (e.g. Tomasello *et al.*, 2007). Many studies now provide support for the view that, from early on, infants point communicatively in order to share their interest in objects and events (e.g. Liszkowski *et al.*, 2007a). However, it is still an open question why infants are motivated to share their interests with those around them. One possibility is that this motivation to share interest is a product of a uniquely human adaptation for engaging in collaborative activities with other members of our species (Liszkowski, 2005; Tomasello *et al.*, 2007). Thus, infants' desire to share their interests with others is one manifestation of a cognition adapted for cooperation and collaboration with other members of one's social group. A further possibility is that infants are motivated to share their interest in objects and events because they want others to provide them with information about these objects and events (Southgate *et al.*, 2007). Although pointing still reflects a desire to share attention, the motivation is quite different. On this view, infants point because they desire information about an object or event and perceive that the recipient of their pointing could provide this.

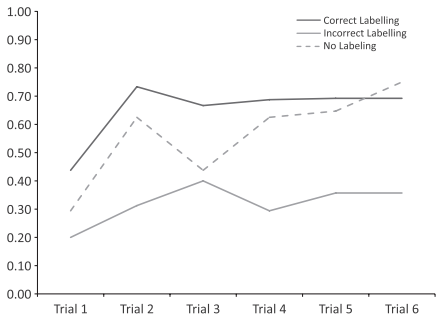

Figure 3 *The proportion of infants in each condition that pointed to the target object on each of the six test trials.*

Our finding, that infants point more in the presence of a demonstrably knowledgeable or reliable experimenter (*Correct Labelling* condition) than an incompetent experimenter (*Incorrect Labelling* condition), is more consistent with the second view: that infants are motivated to share their attention with others because they want to obtain some information about the referent of their gesture. As infants were equally willing to interact, exchange objects, and engage in play with both the competent and incompetent experimenter, it is unlikely that infants pointed less in the *Incorrect Labelling* condition because they perceived the experimenter to be mean or bizarre (Lucas & Lewis, 2010). Instead, the fact that pointing to novel objects was the only behaviour differing between the conditions suggests that pointing was deployed with a particular motivation: to obtain information. Had infants pointed with other motivations, such as to obtain objects or attention to themselves (Moore & D'Entremont, 2001), to share their attitude towards the object, or to inform the adult of the presence of an object that she cannot see (Liszkowski, 2005; Liszkowski *et al.*, 2007a), then pointing to novel objects – like the other behaviors we coded – should not have differed between conditions.

The results of the *No Labelling* condition of Experiment 2 suggest that it was specifically the mislabelling of objects, rather than the uncertainty of the response to previous points, that led infants in the *Incorrect Labelling* condition of Experiment 1 to point less. Since previous research has only investigated understanding of uncertainty in children of 2 years and older (Birch *et al.*, 2006), we cannot be sure that the infants in our study understood the significance of an uncertain response for learning from that person, or whether uncertainty is sufficient to deter infants from seeking information from that person. The fact that, even in the absence of any evidence for competence, infants in Experiment 2 pointed to a similar extent as infants in the *Correct Labelling* condition of Experiment 1, suggests that infants may have an expectation of competence in adults and that this needs to be overridden by evidence of incompetence. Similar findings are reported by Corriveau, Meints and

Harris (2009). While infants in the second year of life have previously been shown able to detect and use information about adults' reliability when choosing whose action to imitate (Zmyj *et al*., 2010), or whose information to trust (Koenig & Woodward, 2010), our data show that the perceived reliability of the source affects not only infants' imitation or trust, but also infants' *eliciting* of information exchange.

The finding that one function of early pointing is obtaining information provides an explanation for a number of previous findings. For example, Franco, Perucchini and March (2009) reported that infants pointed significantly less in the presence of other infants than in the presence of adults. As infants of this age appear not to view peers as potential sources of information (Seehagen & Herbert, 2011), this could support the idea that pointing is modulated by the potential of the recipient to impart knowledge. Masataka (2003) reports that 8-month-olds exhibit more index-finger extension (thought to be a precursor to pointing) in the presence of novel than familiar objects. As infants would be expected to require more information about unfamiliar than familiar objects or events, this finding is in line with our conclusions. Liszkowski, Carpenter & Tomasello (2007b) report that infants' pointing increased in response to the experimenter's 'positive commenting'. While this may reflect infants satisfaction that the experimenter is sharing attention with them (Liszkowski *et al*., 2007b), a further possibility is that infants interpret such 'positive commenting' as information about the referent's valence, and increased pointing in response might reflect infants' satisfaction that the experimenter is providing them with information (Southgate *et al*., 2007). Finally, the documented positive relationship between infant pointing and vocabulary acquisition (Brooks & Meltzoff, 2008; Goldin-Meadow *et al*., 2007) fits well with the hypothesis that infants point in order to obtain information.

As the infants in the current study were 16 months old, we do not know whether such an interrogative function is present at the onset of pointing, which may be as early as 9 months of age. Some researchers argue that, at its onset, pointing is a non-communicative act (e.g. Bates *et al*., 1975). Thus, one possibility is that infants learn that they receive information in response to their points, and only later do they point, communicatively, in order to obtain information. Regardless of whether pointing is interrogative at its onset, or becomes interrogative as a result of learning, infants' ability to elicit information from adults could serve as a powerful cultural learning tool. While caregivers of course do not require a request from the infant in order to provide information, it is unknown whether infants assimilate solicited and unsolicited information equally well. It is known that, in adults, information received in response to expressions of interest is better learned than unsolicited information (e.g. Silvia, 2006; Kang, Hsu, Krajbich, Loewenstein, McClure, Wang & Camerer, 2009). While previous research has shown that information received contingently with other expressions of interest, like object-directed babbling, is learned better than information received non-contingently (Goldstein, Schwade, Briech & Syal, 2010), a question for future research is whether interrogative pointing in infancy might, similarly, reflect a readiness to learn, and result in better learning. The finding that labels, provided in response to infant pointing, are the most likely to be incorporated into the vocabulary (Goldin-Meadow *et al*., 2007) might be interpreted as suggesting this.[4]

In sum, we have shown that infants in the second year of life point more when they perceive that the recipient of their pointing is someone who could provide them with information. Whereas recent theories portray infants' early pointing as manifestations of an early developing cooperative and collaborative social cognition (Tomasello *et al*., 2007), where the aim of pointing is to share attention and interest, our data suggest that one of the reasons that infants might want to share interest with others is because, by doing so, these knowledgeable others will provide information about the object or event of interest.

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References

Bates, E., Camaioni, L., & Volterra, V. (1975). The acquisition of performatives prior to speech. *Merril-Palmer Quarterly*, **21**, 205–224.

Birch, S., Frampton, K., & Akmal, N. (2006). The medium is the message: how infants' sensitivity to nonverbal cues influences what they learn from others. Paper presented at the annual meeting of the XVth Biennial International Conference on Infant Studies, Westin Miyako, Kyoto, Japan.

Brooks, R., & Meltzoff, A.N. (2008). Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: a longitudinal, growth curve modeling study. *Journal of Child Language*, **35**, 207–220.

Camaioni, L., Perucchini, P., Bellagamba, F., & Colonnesi, C. (2004). The role of declarative pointing in developing a theory of mind. *Infancy*, **5** (3), 291–308.

[4] It is important to note that better learning of information provided in response to expressions of interest like babbling may simply be the result of heightened attention, and need not imply that infants intended to communicate their interest via such expressions, or to elicit information from others. In the case of pointing, however, Tomasello and colleagues have demonstrated that, from at least 12 months of age, pointing is a truly communicative act (Tomasello *et al*., 2007).

Chow, V., Poulin-Dubois, D., & Lewis, J. (2008). To see or not to see: infants prefer to follow the gaze of a reliable looker. *Developmental Science*, **11** (5), 761–770.

Corriveau, K.H., Meints, K., & Harris, P.L. (2009). Early tracking of informant accuracy and inaccuracy. *British Journal of Developmental Psychology*, **27** (2), 331–342.

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences*, **13**, 148–153.

Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B*, **366**, 1149–1157.

Farroni, T., Johnson, M.H., Menon, E., Zulian, L., Faraguna, D., & Csibra, G. (2005). Newborns' preference for face-relevant stimuli: effect of contrast polarity. *Proceedings of the National Academy of Sciences, USA*, **102** (47), 17245–17252.

Franco, F., Perucchini, P., & March, B. (2009). Is infant initiation of joint attention by pointing affected by type of interaction? *Social Development*, **18** (1), 51–76.

Goldin-Meadow, S., Goodrich, W., Sauer, E., & Iverson, J. (2007). Young children use their hands to tell their mothers what to say. *Developmental Science*, **10** (6), 778–785.

Goldstein, M.H., Schwade, J., Briech, J., & Syal, S. (2010). Learning while babbling: prelinguistic object-directed vocalizations indicate a readiness to learn. *Infancy*, **15** (4), 362–391.

Hannan, T.E. (1992). An examination of spontaneous pointing in 20- to 50-month-old children. *Perceptual and Motor Skills*, **74** (2), 651–658.

Iverson, J.M., & Goldin-Meadow, S. (2005). Gesture paves the way for language development. *Psychological Science*, **16**, 367–371.

Jaswal, V.K., & Malone, L.S. (2007). Turning believers into skeptics: 3-year-olds' sensitivity to cues to speaker credibility. *Journal of Cognition and Development*, **8**, 263–283.

Kang, M.J., Hsu, M., Krajbich, I.M., Loewenstein, G., McClure, S.M., Wang, J.T., & Camerer, C.F. (2009). The wick in the candle of learning: epistemic curiosity activates reward circuitry and enhances memory. *Psychological Science*, **20** (8), 963–973.

Kishimoto, T., Shizawa, Y., Yasuda, J., Hinobayashi, T., & Minami, T. (2007). Do pointing gestures by infants provoke comments from adults? *Infant Behavior and Development*, **30**, 562–567.

Koenig, M.A., & Echols, C.H. (2003). Infants' understanding of false labelling events: the referential role of words and the speakers who use them. *Cognition*, **87**, 179–208.

Koenig, M.A., & Woodward, A.L. (2010). Sensitivity of 24-month-olds to the prior inaccuracy of the source: possible mechanisms. *Developmental Psychology*, **46** (4), 815–826.

Leung, E.H.L., & Rheingold, H.L. (1981). Development of pointing as a social gesture. *Developmental Psychology*, **17**, 215–220.

Liszkowski, U. (2005). Human twelve-month-olds point cooperatively to share interest with and helpfully provide information for a communicative partner. *Gesture*, **5** (1/2), 135–154.

Liszkowski, U., Carpenter, M., Striano, T., & Tomasello, M. (2006). Twelve- and 18-month-olds point to provide information for others. *Journal of Cognition and Development*, **7** (2), 173–187.

Liszkowski, U., Carpenter, M., & Tomasello, M. (2007a). Pointing out new news, old news, and absent referents at 12 months. *Developmental Science*, **10**, F1–F7.

Liszkowski, U., Carpenter, M., & Tomasello, M. (2007b). Reference and attitude in infant pointing. *Journal of Child Language*, **34** (1), 1–20.

Lucas, A.J., & Lewis, C. (2010). Should we trust experiments on trust? *Human Development*, **53** (4), 167–172.

Masataka, N. (2003). From index-finger extension to index-finger pointing: ontogenesis of pointing in preverbal infants. In S. Kita (Ed.), *Pointing: Where language, culture, and cognition meet* (pp. 69–84). Mahwah, NJ: Lawrence Erlbaum.

Moore, C., & D'Entremont, B. (2001). Developmental changes in pointing as a function of parent's attentional focus. *Journal of Cognition and Development*, **2**, 109–129.

Seehagen, S., & Herbert, J.S. (2011). Infant imitation from televised peer and adult models. *Infancy*, **16** (2), 113–136.

Silvia, P.J. (2006). *Exploring the psychology of interest*. New York: Oxford University Press.

Southgate, V., Chevallier, C., & Csibra, G. (2009). Sensitivity to communicative relevance tells young children what to imitate. *Developmental Science*, **12**, 1013–1019.

Southgate, V., van Maanen, C., & Csibra, G. (2007). Infant pointing: communication to cooperate or communication to learn? *Child Development*, **78** (3), 735–740.

Tomasello, M., Carpenter, M., & Liszkowski, U. (2007). A new look at infant pointing. *Child Development*, **78** (3), 705–722.

Topal, J., Gergely, G., Miklosi, A., Erdohegyi, A., & Csibra, G. (2008). Infant perseverative errors are induced by pragmatic misinterpretation. *Science*, **321**, 1831–1834.

Yoon, Y.M.D., Johnson, M.H., & Csibra, G. (2008). Communication induced memory biases in preverbal infants. *Proceedings of the National Academy of Sciences, USA*, **105** (36), 13690–13695.

Zmyj, N., Buttelmann, D., Carpenter, M.J., & Daum, M.M. (2010). The reliability of a model influences 14-month-olds' imitation. *Journal of Experimental Child Psychology*, **106**, 208–220.

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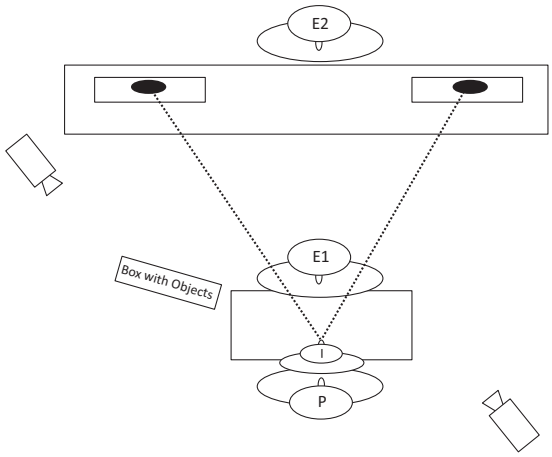

Many studies have converged on the view that infant pointing reflects a motivation to share attention and interest with others. We tested a hypothesis in which the goal of pointing is not attention sharing itself, but the information-laden response that infants tend to receive as a result of sharing attention. Our results suggest that one function of pointing in infancy is to obtain information from others, and that infants selectively elicit desired information from those who they perceive could competently provide it.