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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 47(0)

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Publication Date
2025

What or where? Infants Interpret Pointing as Referring to a Location Rather Than to a Specific Object

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Abstract

Humans often interpret pointing as referring to an object, however, it can also indicate a direction or relevant spatial location. We investigated which one of these interpretations can explain 14-month-olds responses in a two-alternative choice task. We conducted three experiments, in which an experimenter pointed at one of the two lateral objects, swapped their positions in full view of the infant, and then allowed the infant to choose. Pointing was either produced in an Ostensive Addressing (Experiment 1), Nonostensive Addressing (Experiment 2), or Ostensive Labelling context (Experiment 3). In the Ostensive Addressing and Ostensive Labelling experiments infants chose the non-indicated object in the indicated direction significantly more often than predicted by chance. In contrast, in the Nonostenive Addressing experiment, infants' performance was on chance. These findings suggest that infants follow the direction of pointing rather than interpreting it as indicating a specific object in a communicative context.

Keywords: infant; pointing; referent identification; location bias; perseveration; pragmatics

Introduction

Humans evolved a species-unique communication system, which allows them to correctly interpret and produce referential signals that can convey information about objects, events, various properties of these entities or even the relation between them. It was proposed (Waxman & Gelman, 2009) that when interpreting verbal or non-verbal communicative actions, humans do not simply rely on the correlation between signals and their referents (i.e., that a certain entity is often accompanied by a particular string of sounds). Rather, they understand that communicative signals are used to convey information about relevant aspects of reality (Grice, 1991; Sperber & Wilson, 1986; Wilson & Sperber, 2012) based on the communicator's mental representations of the world.

This understanding enables human communication to transfer information about displaced and abstract referents (Hockett & Hockett, 1960), such as absent entities (Ganea & Saylor, 2013; Ganea, et al., 2007) or scientific concepts. It was argued that this ability plays a fundamental role in enabling large-scale cooperation and the formation of complex social groups and cultures (Tomasello, 2009; Tennie, Call & Tomasello, 2018), as well as in the intra- and intergenerational knowledge transfer about generic facts (e.g., that the Earth revolves around the Sun), which—consequently—do not have to be rediscovered by each individual separately (Csibra & Gergely, 2009, 2011).

However, the versatility of communicative signals, which enables them to refer to a wide variety of entities, whether present or absent, comes with a cost. Human communicative signals are inherently underdetermined and, therefore, ambiguous. Consequently, humans have to possess two abilities from early on to successfully identify the referents of signals. First, they must be able to identify signals that enable communicative information transfer. Second, they have to rely on pragmatic inferences based on the current situational and cognitive context (e.g., common ground; Clark, 2015) to understand their most likely meaning.

The ability to identify communicative signals emerges early in human cognitive development. Young infants can recognize ostensive cues indicating a speaker's communicative intent, enabling them to understand when they are being addressed (Csibra & Gergely, 2011). For instance, they are sensitive to mutual eye-gaze (Farroni, et al., 2002), infant-directed speech (Cooper & Aslin, 1990), their own name (Parise, Friederici, & Striano, 2010), contingent reactivity (Johnson, Slaughter, & Carey, 1998), and the informativity of communicative signals (Tauzin & Gergely, 2019; Vouloumanos, Martin & Onishi, 2014).

Infants also possess the ability to infer the most likely meaning of referential signals based on the situational and cognitive context (Tauzin & Gergely, 2018). For example, from the preverbal stage of development, they can understand that indexical non-verbal actions can convey relevant information about a referent entity. Recent evidence shows that infants follow the eye-gaze (D'Entremont, Hains, & Muir, 1997; Senju & Csibra, 2008; von Hofsten, Dahlström, & Fredriksson, 2005) and orientation change (Movellan & Watson, 2002; Tauzin & Gergely, 2019, 2021) of

In D. Barner, N.R. Bramley, A. Ruggeri and C.M. Walker (Eds.), *Proceedings of the 47th Annual Conference of the Cognitive Science Society*

communicative agents to look at an object aligned with the axis of the indexical signal (e.g., the communicator's line of sight).

The ability to interpret and produce pointing also emerges during infants' first year of life (Carpenter, Nagell, & Tomasello, 1998). Eye-tracking results suggest that around 4 to 6 months of age, infants are capable of orienting their attention in the direction of deictic pointing gestures (Bertenthal, Boyer, & Harding, 2014; Rohlfing, Longo & Bertenthal, 2012). Moreover, by 12 months of age, they are also able to correctly search for a hidden object, which was ostensively pointed at by an experimenter in a two-alternative choice task (Behne, Liszkowski, Carpenter & Tomasello, 2012). When doing so, infants perceive pointing—in contrast to moving a fist closer to an object (Krehm, Onishi, & Vouloumanos, 2014)—as a referential action indicating a relevant entity in the given communicative context (Liebal, Behne, Carpenter, & Tomasello, 2009).

It was proposed that pointing gestures may have a proto-imperative (e.g., "give that object to me") or proto-declarative (e.g., "it is an interesting object") function in infants (Bates, Camaioni, & Volterra, 1975). Liszkowski and colleagues provided ample evidence that infants point to share relevant information with others (Liszkowski, et al., 2004; Liszkowski, Carpenter, & Tomasello, 2007; Liszkowski, 2020). Further studies revealed that infants can also use deictic pointing in a proto-interrogative manner to request more information about a target referent (Begus & Southgate, 2012; Kovács et al., 2014). Importantly, when doing so, infants can take into account the relevant epistemic mental states of their addressee (Tomasello, Carpenter & Liszkowski, 2007). They point more often for addressees who lack relevant information (O'Neill, 1996; O'Neill & Topolovec, 2001) or possess incorrect information (Knudsen & Liszkowski, 2012a, b) about a goal-relevant fact, such as the location of an object. They also provide their communicative partners with a sufficient amount of information depending on the relevant epistemic mental states of their addressee. Thus, they are more likely to produce disambiguated points for someone with no or incorrect information as opposed to someone who is a knowledgeable (Tauzin, Call & Gergely, 2024). These results suggest that infants rely on pragmatic inferences when producing non-verbal communicative gestures, such as points.

Importantly, similar to other human communicative actions, pointing is also inherently ambiguous. In certain contexts, referential pointing indicates a particular object (e.g., "can you see *that* dog?") or object kind (e.g., "*this* is a dog"). In other situations, pointing refers to a location or direction of a relevant entity (e.g., "I saw the dog sitting *over there*"). Previous findings on infants' interpretation of human pointing suggested that they understand pointing as referring to an object rather than a location. For instance, in a looking time study (Yoon, Johnson & Csibra, 2008), 9-month-olds were found to encode the features of an object better after it had been ostensively pointed at. Accordingly, infants showed a violation of expectation reaction when the shape, as opposed to the location, of the referent object changed. In contrast, when the same object was non-communicatively reached for, infants encoded the location of the object more thoroughly. Thus, they showed a violation of expectation reaction when the object's location changed, but not when its shape did. In another looking time experiment (Woodward & Guajardo, 2002), 12-month-olds were habituated to a pointing gesture indicating a teddy bear on the left-hand side instead of a ball on the right-hand side. After the two objects were swapped, the infants expected the communicator to continue pointing at the teddy bear despite its location having been changed. These studies together suggest that infants have an early emerging tendency to understand that deictic pointing indicates entities and not their location or direction.

However, the results of the Yoon and colleagues (2008) study could not be replicated (Silverstein, Gliga, Westermann, & Parise, 2019). At the same time, the design of the Woodward & Guajardo (2002) study was confounded for two reasons. First, because it measured whether infants understand pointing as an expression of a stable preference, as the same object was pointed at repeatedly during the habituation phase. Although this might be one specific function of pointing, deictic points are usually employed to highlight something relevant or novel in the environment (Kovács et al., 2014). Second, because the protagonist always touched the target object with her index finger, which might be interpreted as proximal pointing, but could also be perceived as an instrumental action, such as poking or a gentle push. Since young infants expect instrumental non-communicative actions (e.g., a goal-directed approach) to be directed towards the same goal-object (Gergely & Csibra, 2003; Woodward, 1998), it is possible that the results of Woodward & Guajardo (2002) reflect this effect (see also Cho, Lee, & Song, 2021).

Crucially, in other studies examining infants' understanding of pointing (Behne, et al., 2012; Bertenthal, Boyer, & Harding, 2014; Krehm, Onishi, & Vouloumanos, 2014; Rohlfing, Longo & Bertenthal, 2012) location- and object-related information were not pitted against each other. Thus, the query remained open as to whether young infants' default, spontaneous interpretation of a communicator's pointing gesture is that it refers to an entity or a location.

Experiment 1 – Ostensive Addressing

To examine this question, we designed a paradigm based on a previous comparative study (Tauzin et al., 2015). In the warm-up phase, the experimenter looked at the infant and addressed her using infant-directed speech ("Hello, [infant's name]! Look here"). After the infant was paying attention to the experimenter, she placed two objects laterally on the table and pointed at one of them. The infants were then ostensively asked to choose an object ("Now it's your turn"). If they pointed at, reached for, or touched one of the objects, the indicated object was given to them, and they could briefly play with it. When they chose the referent of the deictic gesture in two consecutive trials, the test phase started.

Figure 1: The steps of the test phase in Experiment 1.

The test phase was the same as the warm-up phase except that after the experimenter's pointing, she swapped the location of the two objects in full view of the infant and then asked the participant to choose an object (see Figure 1).

We hypothesized that if infants interpret the pointing gesture as indicating an object, they will choose the target referent at its new location. However, if infants interpret the pointing gesture as referring to a location or direction, we predicted that they would select the non-referent object located on the indicated side.

Methods

Participants Since our experiment required infants to understand the intended meaning of the experimenter's pointing gesture, we tested 14-month-old infants, who were shown to already have sophisticated pragmatic inferential skills (Tauzin & Gergely, 2018). We included 24 healthy, full-term 14-month-old infants in the final sample of the Ostensive Addressing experiment (9 females, M_{age} = 439.72 days, *SD* = 8.36 days).

We excluded 29 infants from the final analysis based on predefined exclusion criteria. Twenty-four infants were excluded because they failed to choose the target object in at least two consecutive trials during the warm-up phase. A further 3 infants were excluded due to fussiness and 1 due to repeated experimenter errors. We also excluded 1 infant whose performance deviated by more than three standard deviations from the group mean. Exclusions were made throughout data collection, and we continued to recruit new participants until the target sample size of 24 infants per condition was reached. The sample size was determined through an a priori power analysis to achieve a power of 0.8 with a medium effect size ($d \approx 0.5$).

Apparatus During the experiment, the infants sat on their parents' laps (seat height 42 cm) approximately 10 cm from the front edge of the table (table height 71 cm, width 120 cm, depth 60 cm). The experimenter was seated on the other side of the table, facing the infant. Two plush toys (height 10 cm, width 8 cm, depth 4 cm) with animal faces were used during both the warm-up and test phases. The two toys were clearly distinguishable: one was white and resembled a seal, while the other was brown and resembled a sloth. The toys were placed laterally on the table in predetermined positions so that one toy was on the left side of the infant and the other on the right side (36 cm from the side edges of the table, 25 cm from the participant). Infants' behavior was video recorded by an Insta360 camera.

Procedure The experimental procedure consisted of two phases: a warm-up phase and a test phase. The aim of the warm-up phase was to familiarize the infants with the set-up and paradigm. Once the parent and infant were seated, the experimenter took her place on the other side of the table. At the beginning of each trial, the two toys were placed on the experimenter's lap. The experimenter then made eye contact with the infant, smiled, and called their name by saying the German equivalent of "Hello, [Name]! Look here!" ("Hallo, [Name]! Schau mal hier!") using infant-directed speech. Next, the experimenter slowly placed the two objects from her lap on the table, one after the other, in full view of the infant. During this process, she exchanged looks between the toys and the infant to ensure that they were paying attention to the placement of the objects. Once the toys were placed, the experimenter looked at the infant and pointed at the target object by bending her arm at the elbow and holding an ipsilateral momentary point for 2–3 seconds while turning her head to look at the object. When the pointing gesture was finished, the experimenter looked back at the infant and said, "Now it's your turn!" ("Jetzt bist du dran!"). Parents were instructed to hold their infants and prevent them from reaching for the objects before the pointing gesture was completed. The infants had 20 seconds to choose an object by either touching it, reaching for it (by moving their hand within 15 cm of one of the toys), or pointing at it. If the infant did not make a choice after 6 to 10 seconds, the experimenter prompted them again with the sentence "You can choose something!" ("Du darfst dir was aussuchen!"). Infants were allowed to make a single choice. In case the choice behavior was ambiguous (e.g., reaching for both objects at the same time), the experimenter waited until the first unambiguous choice. After an unambiguous choice action, the experimenter gave the chosen plush toy to the infant and said, "There you have it!" ("Da hast du es!"). The infant was allowed to play briefly with the chosen object, while the experimenter removed the other object from the table. If the infant did not reach for the toys for 20 seconds in the first warm-up trial, the toys were given to the infant to familiarize the participant with the objects and facilitate choice behavior in the subsequent trials. If the infant did not make a choice in the subsequent trials, the experimenter took the objects back and started the next trial. The warm-up phase consisted of up to eight trials, however, if the infant chose the target object on two consecutive trials, the experimenter moved on to the test phase. The test phase (eight trials) followed the same procedure as the warm-up phase, except that after pointing at one of the toys, the experimenter slowly swapped the position of the toys by grabbing them at the same time and crossing her arms in front of her in full view of the infant. Thus, the object that was previously pointed at was moved to the position of the non-indicated object on the other side of the table, while the object that was previously not pointed at was moved to the location of the previously indicated object. In the warm-up phase, the side of pointing was alternated across trials (ABABABAB), while the side where the first object was placed, the respective target objects' sides, and the side of the first pointing gesture were counterbalanced across participants. In the test phase, the side of the pointing gesture, the side where the first object was placed, and the respective target objects' sides were counterbalanced within participants, while the side of the first pointing gesture was counterbalanced across participants.

Data analysis The responses of the infants were video-recorded for subsequent offline analysis. We defined choice as any hand action directed towards a single object. Infants could point at, touch or reach for the object. We coded the infants' first response after the last verbal prompt in each trial ("Now it's your turn") to prevent them from correcting their responses. The main measure of interest was the number of choice actions produced to indicate either of the two plush toys. We calculated difference scores based on the selection of the indicated object versus the indicated location for each individual. We analyzed the data in SPSS 20. All tests were two-tailed. A second coder, blind to the hypotheses, analyzed 25% of the subjects included in all experiments. Inter-rater reliability was high (99.23%, Kappa = 0.984).

Results

Difference scores were calculated for each participant ([Target – Location / [Target + Location]), resulting in a range between -1 and +1, with -1 indicating a complete location bias and +1 indicating a complete object bias. Infants' choice performance was significantly different ($t(23) = -2.841$, $p = 0.009$) from chance level (0), showing a location bias ($M = -0.173$, $SD = 0.298$; see Figure 2). Eighteen infants showed a bias to choose either the indicated object or the location more frequently. Among them, significantly more (15/18) infants had a location bias (sign test, $p = 0.008$).

Discussion

The results show that in a two-alternative choice task, infants prefer to choose a non-indicated object in the indicated direction rather than the object that was pointed at previously and moved to a new location. This suggests that when object-related and location-related information are pitted against each other, 14-month-olds tend to interpret pointing as indicating a location or direction rather than an object, comparable to other species (see Tauzin et al., 2015).

However, one could argue that the present findings indicate that infants—similar to their performance in the standard A-not-B task (Piaget, 1954/2013)—commit a perseverative search error when reacting to pointing gestures, and that this is perhaps induced by low-level cognitive mechanisms. Since in the present paradigm infants had to look at the referent object when the experimenter pointed at it, and both objects were visible to them throughout the entire procedure, it is unlikely that the results stem from working memory constraints (Bjork & Cummings, 1984; Diamond, 1990). However, our findings may indicate that it is challenging for infants to inhibit a prepotent motor response (Diamond & Goldman-Rakic, 1989), which was induced by the deictic pointing of their communicative partner. Consequently, infants might have been able to understand that pointing referred to the target object, but their overt behavioral responses did not reflect this understanding, due to their immature cognitive control mechanisms (Diamond & Goldman-Rakic, 1989), which led them to produce erroneous search actions. Based on this account, however, one must predict that infants will perseverate even in a nonostensive context. If pointing serves as a perceptual cue for them, it should highlight the indicated direction regardless of the experimenter's inferred communicative intent.

Experiment 2 – Nonostensive Addressing

To test this question, we designed a further experiment , which was similar to Experiment 1, except that the experimenter provided no ostensive addressing cues when interacting with the infant. Accordingly, she used adult-directed speech, did not call the infant by name, and wore opaque sunglasses throughout the entire session to prevent establishing mutual eye contact. We hypothesized that if infants' performance in Experiment 1 stemmed from the lack of inhibiting a prepotent motor response (Diamond & Goldman-Rakic, 1989), reacting to a pointing gesture in a non-communicative context would elicit the same location bias in them. However, if infants' performance in Experiment 1 reflects their interpretation of communicative pointing as indicating a relevant location for them, they should understand that the same gesture in a non-communicative context does not convey a relevant message. Therefore, they should show no preference for choosing the indicated location or object more frequently, similar to the results in the A-not-B task (Topál et al., 2008).

Methods

Participants We included 24 healthy, full-term 14-month-old infants in the Non-ostensive Addressing condition (13 females, $M_{age} = 439.46$ days, $SD = 8.54$ days). An additional 27 infants were excluded: 26 who did not pass the warm-up phase and 1 infant due to fussiness.

Procedure The Nonostensive Addressing condition was similar to the Ostensive Addressing condition except that the experimenter wore opaque sunglasses to prevent the communicative partner from having mutual eye-gaze. During the test session the experimenter used adult-directed speech instead of child-directed speech, and did not call the infant by their name to provide no ostensive addressing cues.

Results

Infants' choice performance (difference scores: M = 0.027, SD = 0.278) in Experiment 2 showed no significant difference from chance level ($t(23) = 0.474$, $p = 0.64$; see Figure 2). While 16 infants tended to choose either the indicated object or location more frequently, only seven of them exhibited a location bias, which was not significant (sign test: $p = 0.804$). Importantly, there was a significant difference between Experiment 1 and 2, both in infants' choice performance ($t(46) = 2.401$, $p = 0.02$) and in the number of infants showing a location bias (Fisher exact test: $p = 0.036$).

Discussion

The results of Experiment 2 showed that, in a nonostensive context, 14-month-olds have no preference in choosing either the location or the target object indicated by deictic pointing. The significant difference between Experiment 1 and Experiment 2 suggests that infants' performance in the present paradigm was not solely a result of the lack of inhibiting prepotent motor responses, as this low-level mechanism should have led them to show a significant location bias in a nonostensive context as well. Thus, the present pattern of findings supports the hypothesis that, in an ostensive context, infants interpret their communicative partner's pointing gesture as conveying relevant information about a location rather than about an object. Consequently, they did not rely on the same pragmatic inference when the experimenter was nonostensive, and therefore chose randomly from the two objects in front of them in Experiment 2. These results provide evidence for infants' bias to interpret communicative pointing as transmitting episodic, location- or direction-related information in contrast to what was previously proposed (Woodward & Guajardo, 2002; Yoon et al., 2008). Importantly, however, these findings leave open the question of whether infants can override this tendency when provided with further cues.

Experiment 3 – Ostensive Labelling

Previous studies revealed that linguistic labels can facilitate infants to focusing on kind-relevant visual (Althaus & Plunkett, 2016) and arbitrary (Pomiechowska, et al., 2024) properties of observed objects. Thus, to investigate whether verbal information can override infants' tendency to interpret pointing as indicating a location rather than an object, we designed a new experiment in which the experimenter always labelled the object she pointed at ("Look here, this is a Garme/Blotte"). The unfamiliar labels were kept constant across trials, thereby, they could be perceived as the names of the two different objects. We hypothesized that if labelling induces infants to focus more on the relevant properties of the indicated object, they would choose the object, which was pointed at, showing an object choice bias at test. However, if pointing draws infants' attention to a certain location irrespective of the verbal information, they were predicted to choose the non-indicated object on the highlighted side more frequently.

Methods

Participants Twenty-four healthy, full-term 14-month-old infants were tested in the Ostensive Labelling condition (N = 24, 11 females, M_{age} = 441.08 days, SD = 8.27 days). We excluded an additional 41 infants: 30 who did not pass the warm-up phase, 10 due to fussiness, and 1 due to repeated parental intervention.

Procedure The procedure of the Ostensive Labeling experiment was the same as the Ostensive Addressing experiment, except that the target object was labelled by the experimenter after her pointing gesture. We used two unfamiliar pseudowords as labels: Blotte and Garme. Thus, the experimenter pointed to the target object and said, "Look here!" ("Schau mal hier!") in infant-directed speech, exchanged glances between the toy and the infant, and labelled the target object with "This is a Garme/Blotte!" ("Das ist eine Garme/Blotte!"). Pointing continued until the experimenter had finished labelling the object. The referents of labels were counterbalanced across infants.

Results

Infants chose the non-indicated object at the indicated location significantly more frequently than the indicated objects at its new location in Experiment 3 (difference score: M = -0.216, SD = 0.306; $t(23) = -3.453$, $p = 0.02$; see Figure 2). Twenty-one infants showed either an object or a location bias, and among them significantly more (17/21) had a location bias (sign test: $p = 0.007$). Infants' choice performance ($t(46) = 2.877$, $p = 0.006$) and the number of infants showing a location bias (Fisher test: $p = 0.03$) were significantly different in Experiment 3 than in Experiment 2.

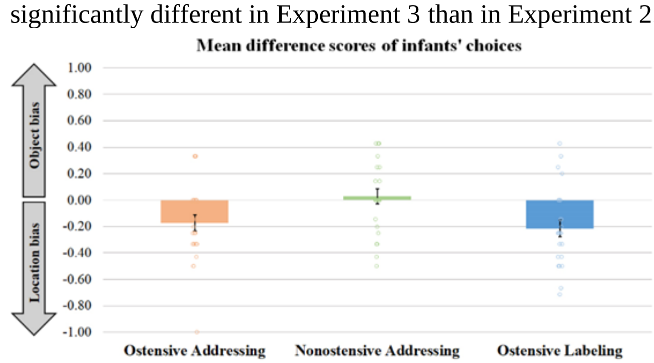

Figure 2: Mean difference scores of infants' choices with SEM (error bars) and individual data points (circles).

Discussion

Experiment 3 replicated the results of Experiment 1, suggesting that infants have a location bias when interpreting the pointing gesture of their communicative partner. Although previous studies have found that labelling induces infants to attend to the relevant features of objects (Althaus

& Plunkett, 2016; Pomiechowska, et al., 2024), this effect could not override infants' tendency to select the indicated location as opposed to the denoted object in the present manual choice task. The results of Experiment 3, therefore, suggest that although infants may pay more attention to the features of referent objects of deictic points in a communicative context, this does not lead them to interpret pointing as a request for a specific target object. Rather, it may serve as a spatial cue for them, inducing spontaneous behavioral responses towards the indicated side, similar to adults' gaze responses in social spatial cuing paradigms (Gregory & Hodgson, 2012).

General discussion

The majority of infants can use and rely on pointing before their first birthday, making this non-verbal gesture a unique and flexible tool for communication before their more sophisticated linguistic abilities develop. Here, we provide evidence that infants spontaneously interpret pointing in a communicative context as referring to the location or direction of a relevant object. Thus, when an object in the indicated location was replaced by another potential referent, infants' choice behavior was guided by their spontaneous interpretation of pointing to choose the cued location.

This function might be relevant, as it can scaffold learning about the world by serving as a disambiguating tool that guides infants' spatial attention to the relevant parts of a complex scene. For instance, in a word learning situation, pointing towards an object and naming it simultaneously can facilitate referent identification by providing disambiguating spatial information along with novel and relevant semantic content. Thus, pointing gestures may serve as a critical and complementary source of spatial information, independently from the content provided by verbal communication.

This hypothesis is supported by previous findings showing that, when an update of spatial information is required, verbal information alone is not sufficient for toddlers. Studies about absent reference indicate that 22-month-olds can rely on verbal testimony to update their mental representations of object state changes (e.g., that an object became wet; Ganea et al., 2007). However, it is not until around 30 months of age that children can update spatial information about absent referents (e.g., that an object was displaced; Ganea & Harris, 2013). We conjecture, therefore, that in such situations deictic gestures might be useful, as they facilitate the efficient and unambiguous transmission of spatial information.

The distinct functions of indexical and verbal signals might also help to explain why conflicting information from these two different sources is difficult for infants to reconcile. For instance, in a false belief paradigm, it was found (Southgate, Chevallier, & Csibra, 2010) that when a protagonist searched for an object—which had been replaced unbeknownst to her—infants could retrieve the object even when the protagonist pointed at the empty container when naming the object. This was interpreted as evidence for infants' ability to understand that the protagonist's false beliefs guided her to point in the wrong direction while referring to the object she had named. Since these results could not always be replicated (Dörrenberg, Rakoczy, & Liszkowski, 2018; Grosse Wiesmann, et al., 2017; Wenzel et al., 2020 but see Király, et al., 2018; Király, Oláh & Kovács, 2023), it was called into question whether infants indeed possess a communicative mentalization ability. However, based on the present findings, we hypothesize that such failure in replicability might be caused by infants' tendency to rely on pointing as a spatial cue, leading them to experience conflict between the contradictory information provided by speech and deictic pointing. Consequently, we assume that infants may indeed possess a communicative mentalization ability (see Tauzin & Gergely, 2018; Tauzin, Call, Gergely, 2024), however, it is easier to demonstrate this capacity in paradigms where infants do not have to resolve conflicting verbal and non-verbal communicative cues.

Our findings suggest that the cognitive adaptation to interpret pointing as indicating a location or direction may reflect an early-emerging sensitivity to relevant spatial information. This ability has likely evolved to support the transmission of disambiguated information by providing non-verbal cues to guide the spatial attention of addressees. Given that this capacity is already present during early word learning, it may play an essential role in language acquisition by aiding referent identification and—through that—the transfer of culturally relevant, generic information.

Crucially, the present results do not necessarily imply that infants learnt about the abstract navigational or manipulatory space around them. It is unlikely that they interpreted the experimenter's pointing gesture as indicating the "left side" or the "space near the edge of the table". Instead, infants might understand pointing as an indicator of the most relevant object in the direction of the deictic signal. This interpretation does not contradict previous findings suggesting that pointing at an object facilitates infants' encoding of its features or supports categorization (Ferguson & Waxman, 2017; Perszyk & Waxman, 2018), as in most cases, the referents are not replaced by other objects. Thus, pointing as a communicative cue might be highly efficient to direct infant's spatial attention to referent objects, helping them to acquire new information about these entities.

One may argue, however, that infants' responses in the present paradigm demonstrate their tendency to imitate others rather than their interpretation of pointing gestures. Thus, 14-month-olds may have chosen the indicated location as opposed to the indicated object because they faithfully copied the experimenter's action. This could explain infants' performance in the warm-up and test phases of the ostensive experiments. However, while this account might explain the performance in the warm-up phase of the Non-ostensive Addressing experiment, it falls short in accounting for the lack of side-congruent choices in the test phase. One might further hypothesize that imitation requires an ostensive context to be induced. However, the warm-up phase in Experiment 2 was also non-ostensive, which should have prevented infants from passing it, thereby rendering the imitation-based account improbable.

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