# The origins of trust: Humans' reliance on communicative cues supersedes firsthand experience during the second year of life

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# Humans' Reliance on Communicative Cues Supersedes Firsthand Experience

# During the Second Year of Life

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## Conflict of interest statement

We have no conflict of interest to disclose.

## Data and materials availability

Detailed descriptive statistics can be found in the Supplementary Materials (table S1-3). Additional data related to this paper may be requested from the authors.

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**Research Highlights**

- We determine the early ontogenesis of human trust in communicated information, assessing the role of age, informants' knowledge, cue's familiarity, and ostension.
- Toddlers and infants trust very strongly familiar and novel communicative cues from well-informed adults, more than their memory of what they just saw.
- Humans' reliance on communication increases during early childhood: Infants are less likely than toddlers to trust familiar and novel cues from poorly informed adults.
- Toddlers' trust in a novel cue that contradicts their first-hand experience is specifically triggered when the cue is used communicatively.

## Abstract

How do people learn about things that they have never perceived or inferred—like molecules, miracles or Marie-Antoinette? For many thinkers, trust is the answer. Humans rely on communicated information, sometimes even when it contradicts blatantly their firsthand experience. We investigate the early ontogeny of this trust using a non-verbal search paradigm in four main studies and three supplementary studies (*N* = 208). Infants and toddlers first see where a reward is, and then an informant communicates to them that it is in another location. We use this general experimental set-up to assess the role of age, informants' knowledge, cue's familiarity, and communicative context on trust in communicated information. Results reveal that infants and toddlers quickly trust familiar and novel communicative cues from well-informed adults. When searching for the reward, they follow a well-informed adults' communicative cue, even when it contradicts what they just saw. Furthermore, infants are less likely to be guided by familiar and novel cues from poorly informed adults than toddlers. Thus, reliance on communication is calibrated during early childhood, up to the point of overriding evidence about informants' knowledge. Moreover, toddlers trust much more strongly a novel cue when it is used in a communicative manner. Toddlers' trust cannot be explained by mere compliance: it is highly reduced when communicated information is pitted against what participants currently see. Thus, humans' strong tendency to rely on familiar and novel communicative cues emerges in infancy, and intensifies during the second year of life.


*Keywords:* cognitive development, trust, social cognition, communication, learning, naïve epistemology.

## Introduction

Humans have strange beliefs. Many would be willing to claim, for instance, that light is both a wave and a particle; that — despite appearances — the earth is round; or that invisible entities such as molecules of oxygen or germs can have a dramatic impact on one's health. In many cases, if asked to justify these claims, the only answer that most would provide is "Someone told me so". The mere fact that a piece of information has been communicated by someone may seem a fragile justification. Yet, it supports the transmission of ideas and behaviors that challenge radically pre-existing intuitions and beliefs, in the scientific, technical, moral, autobiographical, historical or religious domains (Coady, 1992). This reliance on communication does not just enable the diffusion of highly counter-intuitive ideas. It is a cornerstone of human knowledge supporting the fast transmission of cultural information (Csibra & Gergely, 2009; Harris & Koenig, 2006). Human children do not discover individually Pythagoras' theorem or the history of the French Revolution. Instead, the transmission of many forms of knowledge that cannot be acquired individually is supported —in part, or entirely— by a tendency to rely on what others communicate. This form of trust, uniquely developed in humans, allows us to enrich our cognition by capitalizing on the knowledge accumulated by others in the past (Heyes, 2016; Tomasello, 2016). Here, we directly test the ontogenetic emergence of humans' tendency to trust communicated information.

By early childhood, young humans are remarkably trusting. They endorse communicated information that conflicts with their initial beliefs (Jaswal, 2010; Ma & Ganea, 2010). For instance, in Jaswal (2010), 2.5-year-olds searched for a reward hidden in one of three opaque cups. The participants saw in which cup the reward fell, and subsequently, an adult inaccurately claimed that the reward was in another cup. The participants searched for the reward in the cup corresponding to the adult's claim more often than predicted by chance, thus evidencing a strong tendency to trust the adult. Moreover, three-year-olds do not easily withdraw their trust in informants, even when they are poorly informed or deceptive (Call & Tomasello, 1999; Couillard & Woodward, 1999; Jaswal et al., 2010; Mascaro & Sperber, 2009; Mascaro, Morin & Sperber, 2017; Sher, Koenig & Rustichini, 2014; Vanderbilt, Liu & Heyman, 2011). Some communicative actions, such as pointing, elicit in children a robust expectation that the person producing them is well-informed, thereby interfering with children's capacity to recognize who possesses relevant knowledge (Palmquist, Burns & Jaswal, 2012; Palmquist & Jaswal, 2012). Moreover, young children sometimes persist in relying on communicated information that is contradicted by other sources of knowledge (Butler & Markman, 2012, 2016; Hernik & Csibra, 2015; Marno & Csibra, 2015).

These results are all the more noteworthy given infants' and children's remarkable capacities to evaluate the source and content of communicated information and to calibrate their trust accordingly (Bazhydai, Westermann & Parise, 2020; Begus & Southgate, 2012; Castelain, Bernard & Mercier, 2018; Chow, Poulin-Dubois & Lewis, 2008; Dautriche et al., 2021; Kachel et al., 2021; Koenig & Echols, 2003; Tummeltshammer et al., 2014; Koenig & Woodward, 2010; for reviews and meta-analyses, see Clément, 2010; Harris et al., 2018; Poulain-Dubois & Brosseau-Liard, 2016; Sobel & Finiasz, 2020; Tong, Wang & Danovitch, 2020). Therefore, although far from entirely credulous, young humans also have a powerful tendency to rely on communicated information.

How this trust emerges during the first years of life is a long-standing puzzle, raised more than two hundred years ago by philosophers (Hume, 1748/2000; Reid 1764/2000). We address this question by testing the calibration and triggers of trust in communicated information during infancy and toddlerhood. We define trust as the tendency to rely on communicated information, and we focus on reliance on testimony, i.e., on cases in which no argument is given to accept a piece of information other than the fact that it is communicated by someone (Sperber, 2001). We assess reliance on nonverbal indexicals (Burkes, 1949), i.e., signs referring to some objects by means of a direct spatio-temporal connection, such as pointing and markers. To assess the strength of trust, we test participants' reliance on counterclaims (Lane, 2018), i.e., claims that contradict one's first-hand experience.

We asked four research questions. First, we assessed how humans' trust in communication is calibrated during infancy. Moreover, we investigated the factors that may support trust in communicated information during the first years of life. In past studies of toddlers' trust in cues challenging their first-hand experience (Ma & Ganea, 2010; Jaswal, 2010; Jaswal et al., 2014), a knowledgeable adult used familiar cues in a communicative manner. We investigated which of these factors (informants' knowledge, cue's familiarity, and cue's communicative use) triggers trust in communicated information during infancy and toddlerhood.

## Research Question 1: The Calibration of Trust

Our first goal was to investigate how human reliance on communicated information is calibrated during infancy. In principle, infants could start their lives with a strong disposition to rely on communication that they gradually learn to regulate, thus yielding a decrease of trust in the first years of life (Reid, 1764/2000). Alternatively, trust in communicated information may increase during the first years of life (Couillard & Woodward, 1999; Harris et al., 2018; Hume, 1748/2000; Jaswal et al., 2010; Sobel & Kushnir, 2013). This second hypothesis is quite counter-intuitive, since it predicts that toddlers should be more likely than infants to rely on communicated information that contradict their first-hand experience. Yet, there are reasons to believe that it may be correct.

If anything, the massive linguistic and communicative development that children experience during their first three years of life could yield an increase of their reliance on communicated information. As they become better at understanding what people communicate, infants should become more certain about their interpretation of what others mean, and they should access the meaning of what others communicate more frequently and easily. This developmental change should put infants in a better position to recognize, and in some cases, accept, meanings that conflicts with their initial beliefs (Davidson, 1973). Moreover, as infants' capacities to interpret communication improve, they should be in better position to evaluate communicated information's and informants' reliability. Provided that informants are sufficiently reliable, this process could result in an increase in children's tendency to rely on communication (Couillard & Woodward, 1999; Jaswal et al., 2010; Harris et al., 2018; Hume, 1748/2000; Sobel & Kushnir, 2013). An increased confidence in one's assessment of the reliability of communicated information could also make children more likely to build trust quickly in informants and in the cues they provide, given that these informants and cues are reliable. In addition, as children become better at communicating, they should identify genuine disagreements more confidently, and thus, they should be more confident about their social consequences. This process could lead to an increase of children's tendency to rely on communication for social reasons. For instance, it may enhance children's tendency to endorse communicated information to show respect for their interlocutors (Jaswal & Kondrad, 2016; Harris et al., 2018).

In short, humans' reliance on communicated information might increase during the first years of life, for communicative, epistemic and social reasons. We tested this counter-intuitive hypothesis by assessing the development of trust at several time points during infancy and toddlerhood (Studies 1, 2, 2a, 3).

## Research Question 2: The Role of Informants' Knowledge

Our second goal was to investigate the role of informants' knowledge in eliciting trust in infancy and toddlerhood. Preschoolers take into account what individuals have seen to determine who to trust. For instance, they are more likely to trust an informant who had visual access to the content of relevant boxes than an informant who had no visual access (Povinelli & Deblois, 1992;

Robinson, Champion & Mitchell, 1999; Terrier et al., 2016). Here, we focused on the early developmental roots of the human capacity to take informants' knowledge into account, capitalizing on infants and toddlers' sensitivity to what others have seen, or experienced, (see Mazzarella & Pouscoulous, 2021; Phillips et al., 2020 for reviews). First, we tested whether and when toddlers would trust ill-informed individuals. Second, we assessed whether toddlers' trust varies depending on whether informants are well or ill-informed.

## Research Question 3: The Role of Familiarity

Our third goal was to investigate the early onset of humans' trust in unfamiliar communicative cues. Young humans must be able to rely on unfamiliar forms of communication to learn from novel words, demonstrations, gestures, or from other newly encountered communicative cue. Yet, the strength of humans' trust in unfamiliar communicative cues during the first years of life is not known. In fact, available evidence suggests that preschoolers rely less on novel communicative cues than on familiar ones (Couillard & Woodward, 1999; Jaswal et al., 2010). These data do not tell whether a powerful tendency to rely on novel communicative cues might emerge during the first years of life. We addressed these questions by probing infants' and toddlers' trust in a novel communicative cue (Studies 3, 3a).

## Research Question 4: The Role of Communication

Our fourth goal was to investigate the role of communication in triggering trust. Many theories posit that a strong tendency to rely on communicated information is central to cultural transmission during the first years of life (Csibra & Gergely, 2009; Harris & Koenig, 2006; Heyes, 2016; Tomasello, 2016). These theories imply that novel cues should be more likely to be trusted by young children when they are used in a communicative manner, than when they are not. To test this hypothesis, we compared toddlers' use of the exact same novel cue, depending on whether the experimenter signaled her intention to communicate to the child with the cue, or not (Study 4, 4a). We kept the level of accuracy of the novel cue constant across all conditions, irrespective of whether it was used in a communicative, or in a non-communicative manner. Our design allows us to judge between two alternatives. A first possibility is that toddlers are equally likely to build a strong form of trust in any cue that has been reliable in the past, irrespective of whether the cue is used in a communicative manner. Alternatively, cues may be more likely to elicit trust in toddlers when they are used in a communicative manner.

## Operationalization Principle

To evaluate the strength of infants' trust, we pit communication against a pre-existing belief. Participants have to find a reward hidden under one of two containers (Call & Tomasello, 1999). They first see in which container the reward has been placed. Later, an informant indicates —by pointing, or by using a marker— that the reward is in the other container. We assess which source of information participants rely on more by measuring at which place they search when looking for the reward. To evaluate children's sensitivity to the quality of informants, we also manipulate the knowledge of the person communicating to the participant, capitalizing on toddlers' and infants' sensitivity to adults' knowledge (Phillips et al., 2020). In our studies, the person communicating to the participant can be either well-informed or ill-informed about the reward's location. If reliance on communicated information increases during the first years of life, overriding other evidence about the informants' knowledge, toddlers should be more likely than infants to trust an informant that is poorly informed (assuming that infants and toddlers are equally sensitive to informants' knowledge, and that toddlers are more likely to trust communicated information than infants). By contrast, when the informant is well-informed, participants should trust her strongly at all ages, given that they have reasons to expect her to be knowledgeable.

## Ethical Statement

This research complied with relevant ethical regulations and was approved by the Hungarian Ethical Review Committee for Research in Psychology (EPKEB; code: 2013/39). Parents of all participants signed an informed consent form before starting the experiments. Signed informed consent was obtained from the participants' parents for the publication of identifiable images of research participants (videos S1, S2).

## Study 1

### Method

**Participants.** In Study 1 we tested infants in two age-groups and two conditions: 15-month-olds [(low certainty condition *N* = 16: mean age = 469 d; range = 442–484 d) ; (high certainty condition *N* = 16: mean age = 471 d; range = 460–480 d)] and 24-month-olds [(low certainty condition *N* = 16: mean age = 740 d; range = 727–753 d); (high certainty condition *N* = 16: mean age = 741 d; range = 731–752 d)]. We report detailed information about excluded participants for each Study in the Supplementary Methods and Results. Our sample sizes were modeled after comparable studies (Call & Tomasello, 1999). To assess the resulting power to detect main effects when comparing two groups of participants, we ran compromise power analyses with G-Power 3.1 (Faul et al., 2007), with $\alpha = \beta = .05$. These analyses indicated that assuming a large effect (*d* =.8 for Mann-Whitney U tests, *OR* = 9 for Fisher exacts tests), our sample size yielded an implied power equal to .81 (both for comparisons performed with Mann-Whitney U tests and for comparisons performed with Fisher exact tests).

**Materials and procedure.** In Study 1, we tested (i) the development of trust in communication, and its sensitivity to (ii) the informants' state of knowledge and to (iii) the participants' certainty. Participants had to find a reward (a toy) hidden under one of two identical opaque buckets. After a brief warm-up phase, participants were enrolled in two baseline trials that tested their capacity to follow pointing when it was the only source of information. During baseline trials, a first experimenter (E1) hid the toy under one of the buckets. Meanwhile, a screen prevented participants from seeing where the toy was placed. Next, E1 pointed towards the baited bucket, and participants were left free to search for the toy.

After baseline trials, each participant was enrolled in two test trials in which pointing was pitted against memory. Participants first saw in which container the reward had been placed. Later, an informant indicated that the reward was in the other container. We assessed which source of information participants relied on more by measuring at which place they searched when looking for the reward.

In order to assess the effect of informants' knowledge, each participant was enrolled in one false belief trial and in one true belief trial. During false belief trials, E1 hid the toy under one of the buckets while concealed by a cardboard screen, just like in baseline trials. After hiding the reward, E1 pretended to receive a phone call and she left the room. While she was away, the second experimenter (E2) swapped the buckets' locations and revealed the location of the reward by lifting the bucket hiding the toy for about 2 s, before placing it back over the toy. Then E1 came back, she pointed towards the empty bucket, and the child was allowed to search (Video S1). Thus, during the false belief trials, the participants had to choose between relying on the cue from E1 (who was ill-informed about the toy's location), or on their memory of where they saw the toy. True belief trials followed the same procedure as false belief trials, except that E1 came back into the room a few seconds after leaving it, and she witnessed all the actions of E2. As a result, during the true belief trials, E1 was knowledgeable about the toy's location. To avoid carry-over effects from one test to the next one, the two test trials were separated by two filler trials. These filler trials followed the same procedure as baseline trials.

In order to assess whether participants would follow pointing more when tracking the toy's location was harder, we also manipulated the order of the actions performed by E2. Half of the participants were enrolled in the *High certainty condition*, in which E2 first swapped the buckets' locations, and then revealed the toy's location. The other half of participants were enrolled in the *Low certainty condition*, in which E2 first revealed the toy's location, and then swapped the buckets' locations. This manipulation aimed at making it harder to track the toy's final location.

We also ensured that participants could memorize the toy's location in a post-test trial that took place after the last test trial. The latter was identical to test trials, except that (i) E1 did not leave the room after hiding the toy, and (ii) no pointing action was performed. We report further details about the materials, the procedure, and the way the toy's location was counterbalanced for each of the Studies in the Supplementary Methods and Results.

**Coding and data analysis.** Ceiling-mounted cameras recorded participants' behavior. For each trial, we considered that participants found the toy if they lifted first the bucket containing the toy. Further details about coding and analysis are reported in the Supplementary Methods and Results. All reported statistics are two-tailed. Unless specified otherwise, the analyses reported in this paper were planned.

## Results

Detailed descriptive statistics for performance in all Studies are reported in Supplementary Tables S1-3. Preliminary analyses revealed that in Study 1, 15- and 24-month-olds were comparable in their ability to locate the toy using only communication —during baseline trials—, or using only their memory —during post-test trials, excluding the possibility that possible effects of Age on performance during test trials might be due to these factors (all *p*s = 1, see Supplementary Methods and Results). In the subsequent main analyses, we focus on performance during test trials. First we compared the two age group's performance to chance level. Planned comparisons revealed that 15- and 24-month-olds found the toy less often than predicted by chance during the Test of Study 1 (respectively, $W_+ = 69$, $r = -.38$, $p = .034$ and $W_+ = 0$, $r = -.93$, $p < .001$, one-sample Wilcoxon tests, see Fig. 1). Thus, participants from both age groups relied more on pointing than on their memory. Subsequently, from 15 months of age infants have a strong tendency to follow pointing, to the point of ignoring their memory of what they just saw.

To compare the performance of the two age groups, we conducted a hierarchical Bayesian ANOVA (Dong & Wedel, 2017) on success in finding the toy, with Belief (true vs. false belief trial) as a within-subject variable, and with Age (15- vs. 24-month-olds) and Condition (high certainty vs. low certainty) as between-subject variables. This analysis revealed a main effect of Age ($\eta_p^2 = .41$; $p < .001$), indicating that 15-month-olds found the toy significantly more often than 24-month-olds during test trials. Therefore, instead of acting in a more skeptical fashion, older children were more likely to follow pointing than younger ones. The hierarchical Bayesian ANOVA also revealed an interaction between Age and Belief ($\eta_p^2 = .36$; $p = .015$) indicating that the effect of Age was significantly stronger in the false belief trials than in the true belief trials. The hierarchical Bayesian ANOVA revealed no other significant main effect or interaction.

INSERT FIGURE 1 ABOUT HERE

Additional planned analyses investigated the effect of Age in each Belief condition. As Fig. 2 shows, during the true belief trial, 15-month-olds did not find the toy significantly more often than 24-month-olds ($p = .128$, $OR = .31$, Fisher's exact test). The two age groups tended to find the toy less often than expected by chance ($p = .050$ for 15-month-olds and $p < .001$ for 24-month-olds, binomial tests). In short, participants endorsed the pointing of the experimenter when she was well informed, regardless of their age. By contrast, during the false belief trial, 24-month-olds were less likely to find the toy than 15-month-olds ($p < .001$, Fisher's exact test) and only older participants found the toy less often than predicted by chance ($p = .215$ for 15-month-olds and $p < .001$ for 24-month-olds, binomial tests). A complementary analysis showed that the order of belief trials (True vs. False belief first) had no detectable effect on participants' performance (see Supplemental Materials).

INSERT FIGURE 2 ABOUT HERE

## Discussion

In Study 1's true belief condition, all the age groups trusted pointing at ceiling, and more than their first-hand experience. It is possible that the participants' memory of the objects' location was entirely rewritten following the informant's testimony. Alternatively, the participants might have retained a memory trace of where they saw the object, while relying nonetheless more on communicated information. Regardless of whether our participants' memory was entirely rewritten based on the adult's communicative action or not, our data indicate that, from infancy onwards, humans can rely strongly on communicated information.

Furthermore, toddlers trusted more the pointing of a poorly informed adult than infants (in Study 1's false belief condition), thus indicating that human's reliance on a familiar cue (pointing) increases during the second year of life. In Study 2, we investigated the limits of this recalibration of trust, by pitting pointing against very strong evidence supported by direct perception at the moment of pointing (Jaswal, 2010).

# Study 2

## Methods

**Participants.** In Study 2, we tested 15-month-olds (*N* = 16: mean age = 471 d; range = 456–481 d) and 24-month-olds (*N* = 16: mean age = 741 d; range = 730–758 d).

**Materials and procedure.** Study 2 followed the same procedure as the high certainty condition of Study 1, except that one side of the buckets used to hide the toy had a large transparent window (16 x 10 cm). During the warm-up, baseline and filler trials, the buckets' transparent window was turned away from the participants, thus making it impossible for them to see the toy.

During test trials, buckets were oriented so that their transparent window faced the participant. Therefore, subjects could see where the toy was when the informant produced her misleading pointing. If participants follow pointing in an irrepressible fashion, they should keep doing it even in this case. Given that in Study 2 we expected participants to succeed in finding the toy in the test trials (as they could see it through the bucket windows), we did not test them on a post-test trial. Otherwise, the order of trials was the same as in Study 1. Therefore, participants were tested on the following succession of trials: two warm-up trials, two baseline trials, one test trial, two filler trials, and the second test trial.

**Results**

Fifteen- and twenty-four-month-olds were comparable in their ability to locate the toy using only communication —during baseline trials ($p$ = 1, see Supplementary Methods and Results). A hierarchical Bayesian ANOVA on success in finding the toy, with Belief (true vs. false belief trial) as a within-subject variable, and with Age (15- vs. 24-month-olds) as a between-subject variable, revealed no effect of Age or of Belief on performance during Study 2's test trials (all $p$s >. 17). Planned comparisons indicate that in Study 2, participants found the toy more often than predicted by chance at 15 and at 24 months of age (respectively $W_+ = 78$, $r = .86$, $p < .001$ and $W_+ = 112$, $r = .84$, $p < .001$, one-sample Wilcoxon test, see Fig. 2). Thus, participants did not follow pointing when it conflicted directly with visual information. In an additional study, we conceptually replicate that young children's pointing following pointing is not unconditional. In this study, we find that the 15- and 24-month-olds' reliance on pointing is reduced when participants, in addition to having seen where the toy is, also received direct additional evidence that the bucket that the informant points at is empty (see Study 2A in Supplementary Methods and Results).

**Discussion**

Studies 2 and 2A show that infants' and toddlers' trust is not unconditional, and that it is sensitive to the quality of evidence that is pitted against pointing. Thus, the development of reliance on communication observed in Study 1 does not result in an unlimited trust, but rather on a regulated form of reliance on communication.

Studies 1, 2 and 2a focused on pointing, a very special form of communicative action (Kita, 2003), that infants rely on from a very early age (Behne et al., 2012). Infants and toddlers could gradually learn to rely on pointing through experience with this specific communicative cue, without trusting other forms of communication. Alternatively, the capacity to quickly build trust in a communicative cue that we observed in Study 1 may be found for other communicative means, including novel ones. We evaluate these hypotheses in Study 3, by investigating the calibration of children's reliance on a novel cue — placing a marker on top of a bucket (Call & Tomasello, 1999; Couillard & Woodward, 1999). Children can follow this type of novel cue by 18 months of age, and rely on it throughout toddlerhood (Tomasello, Call & Gluckman, 1997; Zlatev et al., 2013).

## Study 3

### Methods

**Participants.** A pilot study revealed that 15-month-olds did not use the marker to locate the toy at all in our paradigm, even when it was the only source of information. As a result, in Study 3 we tested 18-month-olds (*N* = 16: mean age = 556 d; range = 541– 580 d) and 24-month-olds (*N* = 16: mean age = 743 d; range = 732–755 d).

**Materials and procedure.** Study 3 followed the same procedure as Study 1's high certainty condition, except that instead of communicating by pointing, E1 placed a marker (a black plastic disk) on top of a bucket to communicate that it contained the toy (video S2). When she manipulated the marker, E1 sat on a children's chair placed behind the two buckets (from the participants' viewpoint), equidistant from them. Before placing the marker on a bucket, E1 produced ostensive cues signaling her intention to communicate to the child: she looked at the participants in the eyes, and showed the marker to the child by holding it with her right hand at the level of her eyes, while saying: “*Look!*” in infant-directed speech — a distinctive manner of speaking typically used to address young children. Study 3 started with four warm-up trials (instead of two as in Studies 1 and 2) to ensure that our younger participants would have enough experience with the marker to be able to interpret it. In order to gain statistical power, we tested the participants on four test trials (two true belief trials, two false belief trials). These two additional test trials were added at the end of the experiment (one true belief trial, one false belief trial, order counterbalanced) without interspersing them with filler trials to keep the procedure as short as possible. Thus, participants were presented with four warm-up trials, two baseline trials, one test trial, two filler trials, one test trial, one post-test trial, and two test trials.

**Results**

Eighteen- and twenty-four-month-olds were comparable in their ability to locate the toy using only communication —during baseline trials—, or using only their memory —during post-test trials (all *p*s >.20, see Supplementary Methods and Results). A hierarchical Bayesian ANOVA on success in finding the toy in the test trials, with Belief (true vs. false belief trial) as a within-subject variable, and with Age (18- vs. 24-month-olds) as a between-subject variable, revealed a marginally significant main effect of Age ($\eta_p^2$ = .12, *p* = .085), and an interaction between Age and Belief ($\eta_p^2$ = .66, *p* = .010). Therefore, just like in Study 1, the increase in children’s reliance on the communicative cue was stronger when the informant was mistaken (in the false belief test trials) than when she was knowledgeable (in the true belief test trials, see Figure 1).

Planned analyses confirmed that during false belief test trials, performance decreased with age (*U* = 195.5, *r* = .48, *p* = .008, Mann-Whitney U test) and only 24-four-month-olds found the toy less often than predicted by chance ($W_+$ = 6.5, *r* = -.72, *p* = .006 for 24-month-olds, $W_+$ = 33, *r* = .23, *p* = .549 for 18-month-olds, one-sample Wilcoxon tests). Moreover, 18-month-olds found the toy more often during false belief test trials than during true belief test trials ($W_+ = 41.5$, $r = -.66$, $p = .008$, Wilcoxon test for matched pairs). By contrast, belief had no effect on the performance of 24-month-olds during test trials ($W_+ = 1.5$, $r = .20$, $p = .750$, Wilcoxon test for matched pairs).

In contrast, during true belief test trials, age had no effect on participants' level of success ($U = 139$, $r = .08$, $p = .698$, Mann-Whitney U test) and participants of both age groups found the toy less often than predicted by chance ($W_+ = 5$, $r = -.58$, $p = .039$ for 18-month-olds, and $W_+ = 13$, $r = -.58$, $p = .039$ for 24-month-olds, one-sample Wilcoxon tests). In short, when E1 was well-informed, participants from all groups relied on the marker more than on their memory. A complementary analysis showed that the order of presentation of true and false belief trials had no detectable effect on participants' performance (see Supplemental Materials).

In an additional study (Study 3A), we probed further the role of experience in shaping toddlers' trust. This Study followed the same procedure as Study 3, except that we reduced the number of trials preceding the first test. Thus, participants had very limited evidence about the reliability of the marker (specifically only one baseline trial). The results indicated that even with a very minimal exposure to the reliability of the marker, 24-month-olds still rely on it over and above the memory of what they have just seen (see Study 3A, Supplementary Methods and Results).

**Discussion**

In Study 3's true belief trials, all age groups gave more weight to a novel communicative cue than to their first-hand experience, thereby demonstrating a powerful reliance on unfamiliar communicative cues (see also Study 3A). Thus, even 18-month-old participants behaved systematically when the novel cue of a knowledgeable informant conflicted with their memory. Furthermore, during Study 3's false belief trials, the participants' reliance on the marker increased with age, even though experience with this novel communicative cue was constant across age groups. Thus, during the second year of life, toddlers become more likely to trust both familiar, and novel communicative cues. Third, in Study 3, the effect of Belief condition on 18-month-olds' performance indicate that they trusted more an informant when she was knowledgeable than when she was ill-informed. Our data do not tell whether the 18-month-olds encoded the informants' false belief in the false belief condition; the effect the adults' level of knowledge on 18-month-olds' trust in Study 3 can be accounted for by toddlers' well-established capacity to track adults' visual access (Phillips et al., 2020). Remarkably, the interaction between Age and Belief that we observed in Study 3 suggests that as they grow older, toddlers' trust in communication becomes potent enough to override considerations about the informant's knowledge (or lack thereof).

The trust in novel cues that we observed in Studies 3 and 3A could be indiscriminate, and apply to any novel cue. Alternatively, it may be guided by mechanisms allowing children to trust to communicative actions specifically. One likely candidate for guiding the development of trust in novel signals is the recognition of cues indicating an intention to communicate, i.e., "ostensive cues" such as direct eye-gaze towards the participant, and infant-directed speech (Csibra, 2010). If this hypothesis is correct, trust in a novel signal should be reduced when it is not accompanied by ostensive cues. We tested this hypothesis in Study 4.

## Study 4

### Methods

**Participants.** In Study 4, we tested 24-month-olds (*N* = 16: mean age = 745 d; range = 730–760 d), i.e., the age group for which we found the strongest reliance on a novel cue.

**Materials and procedure.** Study 4 followed the same procedure as Study 3, with two exceptions. First, E1 did not manipulate the marker to communicate the location of the toy. Second, E1 did not produce cues indicating her intention to communicate with the marker (she did not show the marker while looking at the participant in the eyes and saying "*Look*" in infant-directed-speech). Instead, in Study 4 the marker was stuck on top of one of the buckets before the experiment began. The toy was hidden under the bucket on which the marker was stuck during warm-up, baseline, and filler trials. It was hidden under the bucket on which the marker was not stuck during test trials.

**Results**

To evaluate whether using the cue in a non-communicative manner reduced participants' trust, we compared the performance of 24-month-olds in Studies 3 and 4. Preliminary analyses confirmed that the 24-month-old participants from Studies 3 and 4 were comparable in their ability to locate the toy using only communication —during baseline trials—, or using only their memory —during post-test trials (all *p*s >.26, see Supplementary Methods and Results). A hierarchical Bayesian ANOVA on success in finding the toy during test trials, with Belief (true vs. false belief trial) as a within-subject variable, and with Study (Study 3 vs. Study 4) as a between-subject variable, revealed a significant main effect of Study ($\eta_p^2 = .38$, $p < .001$) indicating that participants followed more the marker in Study 3, where it was used in an ostensive manner, than in Study 4, where the marker was not accompanied by communicative cues (see Fig. 1). The hierarchical Bayesian ANOVA revealed no other statistically significant effect. Thus, using a novel cue in a communicative manner increases toddlers' tendency to rely on it. Unlike in Study 3, in Study 4 the participants found the toy significantly more often than predicted by chance ($W_+ = 73$, $r = .54$, $p = .046$, one sample Wilcoxon test). Therefore, the participants prioritized their memory over the marker when it was used in a non-communicative manner.

Importantly, in Study 4, when the second experimenter lifted the bucket to reveal the location of the toy, participants could concomitantly see that the marker was placed on the other bucket. Thus, they saw that the toy was in one bucket, while the marker was located on another bucket.  By contrast, they did not have this extra piece of information in Study 3. We controlled for this difference in Study 4A (see Supplementary Methods and Results). Study 4A followed the same procedure as Study 3, except that during the test trials, after hiding the toy, E1 ostensively placed the marker on the empty bucket right before pretending to receive a phone call and leaving the room. Therefore, the marker was already placed on the bucket when E2 swapped the buckets' locations and revealed the location of the toy. The results from this study confirm that toddlers are more likely to rely on a novel signal when it is accompanied by ostensive cues.

## General Discussion

Our studies reveal that toddlers' trust has four key properties. First, it is sufficiently strong to make toddlers rely more on communication than on their memory of what they have just seen (Studies 1, 3, 3A). Such powerful trust is required for the transmission of counter-intuitive cultural information, such as scientific or religious beliefs (Campbell & Corriveau, 2018; Harris & Koenig, 2006; Bloom & Weisberg, 2007). In several studies targeting toddlers' use of testimony to update their representation of the world, participants tended to ignore communicated information (Ganea & Harris, 2010; 2013, but see Ganea et al., 2016). Several factors may explain why participants were more trusting in our case: (i) participants had evidence about the adult informant's reliability before the test and (ii) the delay between the communicative action and the search for the toy was shorter compared to earlier studies. Second, the strong reliance on communicated information that we observed during the second year of life is not unlimited, and it disappears when participants possess sufficiently strong evidence (Studies 2, 2A). A disposition to rely blindly on communicated information could seriously hinder the efficiency of humans' social learning (Harris & Koenig, 2006; Sperber et al., 2010). Accordingly, we find that infants and toddlers stop trusting communicated information when they possess sufficiently strong counter-evidence. Third, the development of trust extends to unfamiliar communicative cues, such that our participants relied more on a novel communicative cue with which they had only a very limited experience than on their first-hand experience (Studies 3, 3a). The capacity to trust informants using novel cues is crucial to learn from and about new forms of communication, such as novel words or demonstrations of unfamiliar actions. Fourth, toddlers' reliance on a novel cue is much reduced when it is not used in a communicative manner (Studies 4, 4a). Thus, toddlers' high level of reliance on a novel cue is appropriately triggered by communicative behaviors. Our results also reveal how age, informants' knowledge, familiarity of the cue and communicative behaviors shape trust in cues during infancy and toddlerhood.

## The Calibration of Trust

Regardless of how much of the language and communicative faculty is present at birth, infants have to learn, over several years, the communicative conventions and the specific languages of people around them. Thus, the amount of information that young humans can confidently access through communication increases massively during early ontogeny. This change in information intake is comparable in scope to the development of a novel sense. We found that this developmental change is accompanied by an increase in humans' trust in both familiar and novel communicative cues from infancy to toddlerhood (Studies 1, 3). Thus, our data reveal that humans' strong reliance on communicated information is not given from birth, once and for all, and that it is calibrated during early ontogeny. Our data speak against the view that infants would first start with a strong disposition to rely on communication that would gradually decrease during ontogeny. Instead, they suggest that the tendency to rely on communicated information develops during toddlerhood (Couillard & Woodward, 1999; Harris et al., 2018; Hume, 1748/2000; Jaswal et al., 2010; Sobel & Kushnir, 2013).

In our studies, the informant communicated accurately during the baseline and filler trials. Thus, these trials provided the participants with information about the reliability of the communicative cue and of the informant. Subsequently, the development of trust that we observed might result from the joint contribution of two factors. First, it may result from the development of the capacity to quickly build trust in an informant or in a communicative cue, based on witnessing that they were accurate in the past. Second, it may result from the development of a general disposition to rely on communication, irrespective of one's experience with specific cues and informants. Our studies were not designed to judge between these possibilities. Regardless of the respective role of these two factors, our data imply that the tendency to quickly and strongly allocate trust in familiar and novel communicative cues develops during the first years of life.

Our data, combined with those of previous studies, suggest that trust in claims challenging one's initial beliefs may be particularly high during toddlerhood. At 2.5 and 3 years of age, children still often trust an adult's claims that contradicts their memory of objects' locations (Ma & Ganea, 2010; Jaswal, 2010; Jaswal et al., 2014). Importantly, trust in counterclaims decreases in the subsequent years, presumably as a result of improvements in children's memory or in executive functions during the preschool years. For instance, in Ma and Ganea (2010), preschoolers saw where a toy was hidden. Next, an adult told children that the toy was in a different location. In both studies, 4- and 5-year-olds relied more strongly on their memory than on the contradictory information communicated by the adult (see also the "ignore control task" of Call and Tomasello, 1999). Thus, toddlerhood is a developmental window during which children evidence striking tendencies to trust information communicated by adults.

Importantly, to yield learning benefits, children's powerful disposition to rely on communicated information needs to be calibrated appropriately. Thus, the development of trust in counterclaims that we observed is likely to be the starting point of a complex developmental pathway supporting the onset of nuanced abilities to integrate communicated information with other sources. During infancy and childhood, children need for instance to refine their capacities to identify appropriately teaching episodes (Butler & Markman, 2016), as well as their ability to determine when counterclaims might be plausible, and whether and how they might be tested (Lane et al., 2014; Ronfard, Chen & Harris, 2018; Ronfard et al., 2020; Hermansen et al., 2021a, 2021b).

## The Role of Informants' Knowledge

Our data cast light on the effect of informants' knowledge on trust in communication during infancy and toddlerhood. In our studies, when the informant was knowledgeable (in the true belief condition), participants relied on what she communicated at all ages. Such a tendency to trust the informant with a true belief is understandable, given that she was well-informed. Thus, our results show that the capacity to trust counterclaims from knowledgeable informants is already present during infancy. Understandably, since trust in communication was near ceiling in all age-groups when the informant was well-informed, we could not detect any effect of age on trust in the true belief conditions of our studies.

By contrast, in the false belief conditions of our studies, we observed that toddlers were more likely than infants to trust an ill-informed adult. This result suggests that the tendency to rely on communicated information increases during the first years of life, up to the point of overriding evidence about an informant's lack of knowledge. This pattern was most evident in Study 3, in which 18-month-olds trusted less an informant who was poorly informed (in the false belief condition), than an informant who was well-informed (in the true belief condition). In contrast, in Study 3, 24-month-olds' trust in the informant remained equally high regardless of her knowledge status. Thus, infants' sensitivity to informants' knowledge might be gradually overridden by their trust as they grow older.

Our results also have consequences for debates about children's capacity to represent beliefs. In a seminal study Southgate, Chevallier and Csibra (2010) showed that seventeen-month-old infants process the beliefs of informants when interpreting what they communicate. Yet, some studies seem to replicate these results and some others do not (see Dörrenberg et al., 2018; Wenzel et al., 2020 for negative results; Király et al., 2018 for positive results). Our data suggest that trust in an informant might sometimes override toddlers' memory of reality, and, consequently, any putative representation of the informant's false belief that children might have formed. Moreover, our data suggest that the tendency to rely on communicative cues from ill-informed adults increases during the second year of life, and is very strong by 24 months of age. This result might contribute to explain why, in some of the studies using the paradigm by Southgate and colleagues (2010) with 24- and 30-month-old participants, toddlers followed an adult's communicative cue, without taking her beliefs into account.

To assess this conjecture, we re-analyzed data from four studies using Southgate et al.'s paradigm (known as the "Sefo task") with participants under three years of age (*N* = 264, age range = 17-30 months, Dörrenberg et al., 2018; Király et al., 2018; Southgate et al., 2010; Wenzel et al., 2020). Results showed that in the Sefo task, the participants' tendency to follow the experimenter's pointing increased with Age. The participants tested on the Sefo task were also less likely to follow the experimenter's pointing in the false belief condition than in the true belief condition. This effect of Belief interacted with the effect of Age, indicating that in the Sefo task, the effect of belief on children's tendency to follow the adult's pointing decreased with age (see the Supplemental Materials for details and additional discussions). Thus, this analysis of earlier studies is in line with the results of our Studies 1,3. It confirms that children's tendency to follow the communicative cue of an adult increases during toddlerhood, and may become potent enough to override considerations about the informants' knowledge. Subsequently, the development of epistemic trust may contribute to explain why 24-month-old and 30-month-old participants disregard informants' beliefs in studies using Southgate et al.'s paradigm.

## The Role of Familiarity

The results of Studies 3 and 3a indicate that toddlers can rely on a novel communicative cue more than on their own memory, even after very limited experience with the reliability of this cue. These data indicate that children have the capacity to build trust in a novel communicative cue in an extremely fast manner. Studies have shown that reference can be assigned to a novel label very quickly, a phenomenon sometimes called "fast mapping" (Carey & Bartlett, 1978). Evidence for fast mapping is important, because it suggests that reference is not assigned through a slow associative process. We provide evidence for a comparable phenomenon for trust, by showing that very few instances of accurate uses of novel cue are sufficient to elicit a powerful trust in toddlers (e.g., Studies 3, 3a). These results speak against the view that trust in novel cues would be built primarily upon associative processes (since, in our Studies 3 and 3a, toddlers had a lifetime of experience of finding objects where they saw them, while they experienced only a few instances of accurate uses of the novel cue).

Our studies provide striking evidence for toddlers' disposition to trust novel cues. Yet, we doubt that toddlers would accept uncritically any information conveyed by any communicative cue. To illustrate, in our studies, we used a marker, which referred to objects' locations by means of a direct spatio-temporal connection. Thus, while the marker was unfamiliar to children, its use corresponded with children's knowledge of communicative conventions (objects' location are often conveyed by means of direct spatio-temporal connection between a cue and a location, for instance when pointing). In contrast, children might be more reluctant to learn from novel signals used in a way that departs from their expectations about the way people map signals to referents. For instance, around their second birthday, children become unlikely to treat arbitrary gestures or non-linguistic sounds as object labels (Graham & Kilbreath, 2007; Namy & Waxman, 1998; Namy et al., 2004; Wilbourn & Sims, 2013; Woodward & Hoyne, 1999). This phenomenon suggests that by two years of age, children have built strong expectations about the type of signal typically used as a label (linguistic sounds). Due to these expectations, toddlers might be unlikely to rely on novel gestures or on non-linguistic sounds when they are used as labels. More generally, the way children's trust might be extended to various categories of novel signals and cues is an open empirical question.

## The Role of Communication

Trusting very strongly any cue after witnessing that it has been reliable a few times in the past would be rather irrational. Accordingly, in Study 4, toddlers did not trust a novel cue that was used in a non-communicative manner, even though they experienced that it was accurate during the baseline trials. Moreover, toddlers were more likely to trust the same, equally accurate, cue, when it was used in a communicative manner (Studies 3, 4a). Thus, experience with the accuracy of cues alone cannot explain toddlers' trust in them. Instead, our data suggest that the communicative use of cues plays a central role in triggering toddlers' trust. Importantly, when the experimenter used the novel cue in a communicative manner in our Studies, she manipulated it (i) intentionally, and (ii) she produced cues signaling her intention to communicate to the child. Any of these two characteristics, or their combination, might have contributed to trigger toddlers' trust (Butler & Markman, 2012; 2016; Hernik & Csibra, 2015; Moore et al., 2015; Leekam, Solomon & Teoh, 2010; Marno & Csibra, 2015).

In short, our data reveal that children's reliance on communicated information is calibrated during the first years of life. This developmental change yields the emergence of a strong —yet, not unlimited— trust in familiar and unfamiliar communicative means that can support the transmission of novel and counter-intuitive ideas. Here, we focused on children's reliance on information about the location of an object, a type of episodic information. Whether the development of trust that we observed generalizes to other communicative contexts, such as the transmission of semantic information is an important question for future research.

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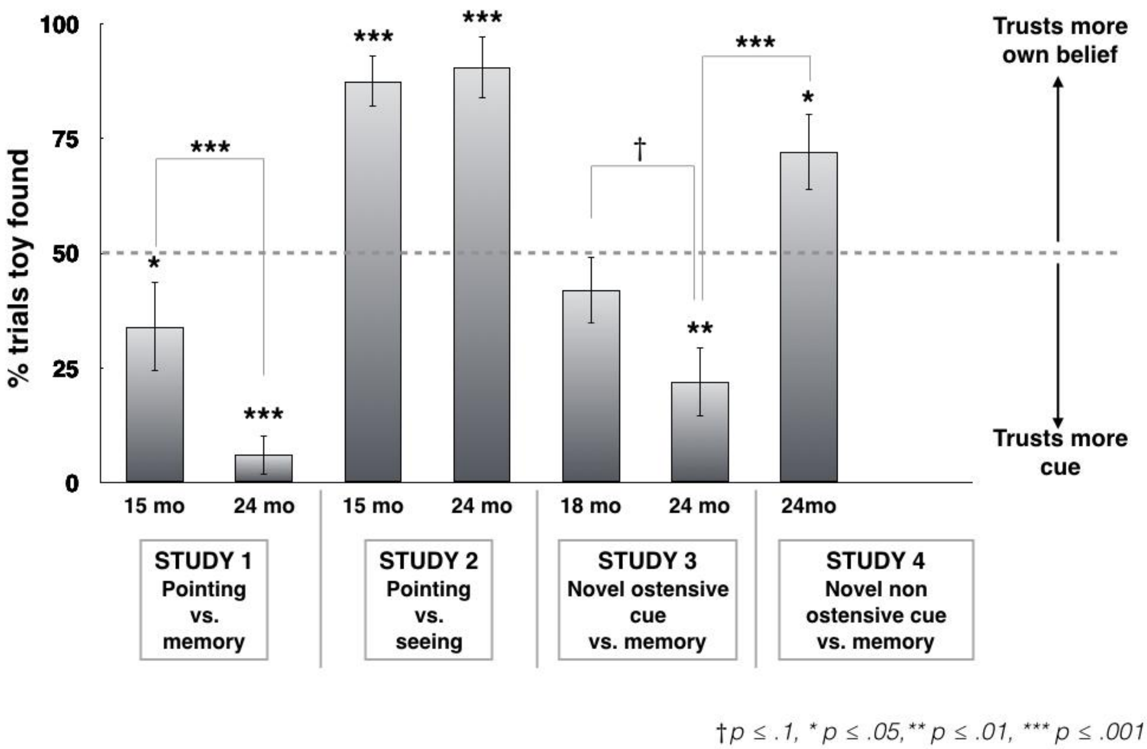


*Figure 1*. Results per Study. Percentage of trials in which participants found the toy (SEM) per Study and Age group.

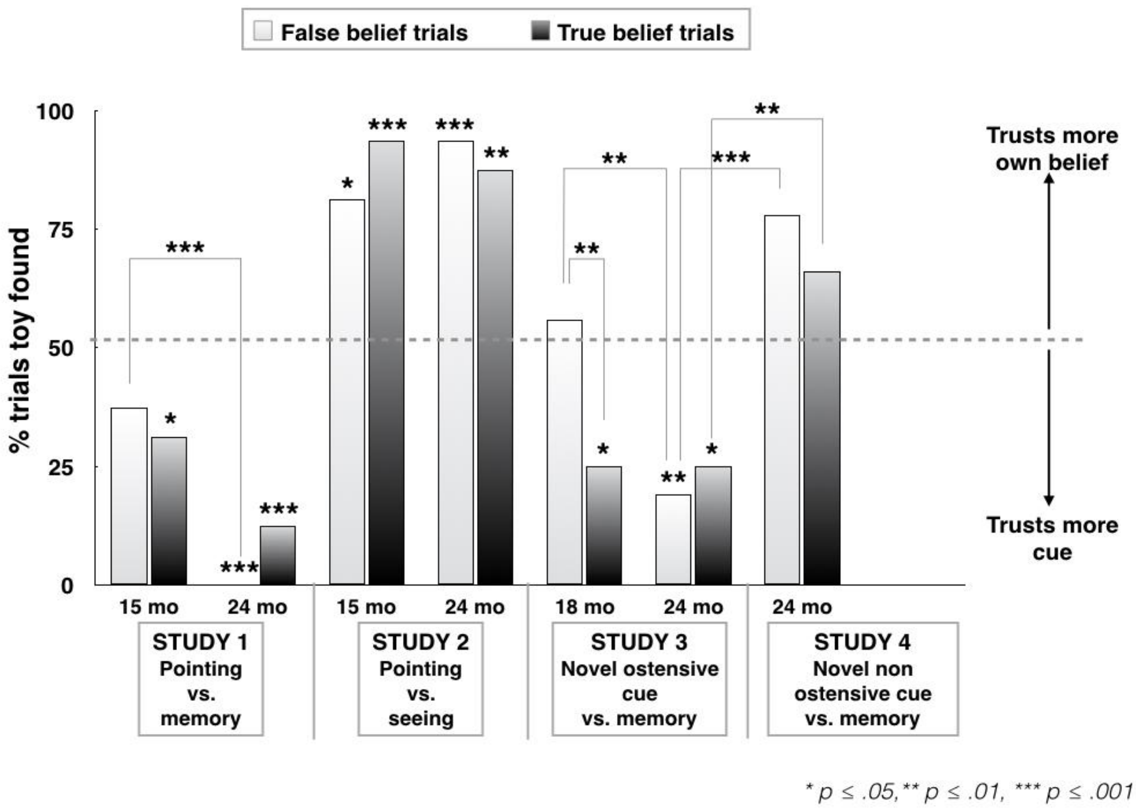


*Figure 2.* Results per Study and Belief condition. Percentage of trials in which participants found the toy per Study, per Age group and Belief condition.

## List of Figures Legends



## List of Supplementary Materials

The manuscript includes the following supplementary materials:

# Supplementary Methods and Results

## Study 1

### Method

**Participants.** In addition to the 64 participants who constituted our sample (16 in each age group and each condition), 16 participants were excluded because of crying/refusing to play the game and/or search (10 15-month-olds, 6 24-month-olds), 6 15-month-olds for side bias, i.e. searching on the same side for seven or more consecutive trials, 6 15-month-olds for failure to understand the game, i.e. not finding the toy in more than half of the warm-up, baseline, and filler trials pooled together, 3 24-month-olds for experimental error, and 1 24-month-old for parental interference.

**Stimuli and Procedure.** At the beginning of each trial, participants were standing on the floor and were held by their caregiver or sitting on her lap. The caregiver sat on a beanbag. A first experimenter (E1) was standing in front of the participants, approximately 3 meters away from them. She placed two identical opaque blue plastic buckets upside down (16.5 cm high, 18 cm wide) on the floor, in front of her, at equidistance from the participants. A second experimenter (E2) was standing by the right wall of the room (from the participant's viewpoint). Participants were tested on the following succession of trials: two warm-up trials, two baseline trials, one test trial, two filler trials, one test trial, and one post-test trial.

***Warm-up.*** During warm-up trials, E1 kneeled down and placed a toy (a small plush dog) under one of the buckets in full view of the participant, before pushing them about 80 cm apart from each other. After hiding the toy, E1 stood up. She ensured that the participant was looking at her by saying: *« Look! »*, and if needed, by calling the participant's name (throughout the procedure, experimenters raised their eyebrows and made eye contact with the participants when they talked to them). Then E1 pointed by fully extending her arm and index finger towards a bucket while also turning her head, and saying *« It's there! Find it!»*. The sentence « *Find it!* » was the cue for caregivers to let participants approach the buckets. When participants were too shy, care-givers were allowed to accompany them, without interfering with their choice. The experimenters waited until the participant found the toy, with their gaze oriented downwards, without looking at the buckets or at the participant. If participants did not select any bucket or did not find the toy after a delay of approximately 30 s, E1 showed the toy by lifting the bucket hiding it. In all cases, after participants found the toy, the experimenters congratulated her by clapping and excitedly saying "*Well done!*" before proceeding to the next trial. Participants were enrolled in two warm-up trials, immediately followed by baseline trials.

***Baseline.*** The baseline trials were similar to the warm-up trials, except that participants did not see where the toy was hidden. At the beginning of the trial, E1 kneeled down behind the buckets. Then E2 placed a large cardboard screen (63 cm high, 116 cm wide) between the buckets and the participant. The screen blocked the participants' view of the buckets and of the toy but allowed them to see E1's head and shoulders. Before hiding the toy, E1 showed it to the participant, by holding it in her two hands above the screen while saying « *Look!* ». Next, E1 lowered the toy behind the screen at the midline, and she placed the toy in-between the buckets, before covering it with one of them. She pushed the two buckets about 80 cm apart from each other. Once the toy was hidden, E2 placed the screen to the side of the room, thus making the buckets visible for the participant. E1 then stood up, and she pointed towards the baited bucket, using the same kinematics as in the warm-up trials. Participants were enrolled in two baseline trials, followed by two test trials separated by filler trials.

***Test.*** Test trials, started exactly like baseline trials, with E1 hiding the toy under one of the buckets while they were concealed by the cardboard screen. Once E2 removed the screen, E1 pretended to receive a call on her cell phone. After E1 left the room, E2 kneeled down next to the buckets. She then (1) swapped the buckets' location, and (2) revealed the location of the toy.

We manipulated the order of these two actions between subjects (high certainty vs. low certainty condition). Half of the participants were enrolled in the *high certainty* condition. In this case, E2 started by swapping the location of the buckets. To make the buckets' location change easier to process for participants, it was performed in three steps, moving one bucket at a time. First, E2 pushed one bucket along a straight path until it was right in front of her, at equidistance of the initial locations of the two buckets. Second, she pushed the other bucket around the first one, following a semi-circular path, up to point the second bucket reached the initial location of the first bucket. Third, E2 further pushed the first bucket along a straight path until it reached the initial position of the second bucket. After swapping the buckets' locations, E2 revealed the toy's location by lifting the bucket hiding it for about 2 seconds, while attracting the participant's attention by saying: « *Look* ». E2 then placed the bucket back on the toy and moved back to the position that she occupied at the beginning of the trial.

The other half of participants were enrolled in the *low certainty* condition, which followed the same procedure as the high certainty condition, with one exception. The order of E2's actions on the buckets was reversed. First E2 revealed the location of the toy by lifting the bucket under which it was hidden, after which she placed the bucket back on the toy. Second, she swapped the buckets' locations. This manipulation aimed at making it harder to track the toy's final location.

We also manipulated whether E1 saw that the toy had been displaced within subjects (true vs. false belief trials). During *false belief* trials, E1 came back into the testing room after E2 finished manipulating the buckets. Therefore, E1 did not see that the buckets' locations had been swapped. During *true belief* trials, E1 came back into the testing room only a few seconds after leaving. Thus, she saw all the actions performed by E2 on the buckets. All participants were enrolled in one true belief test trial and in one false belief test trial (order of presentation counterbalanced across participants).

Test trials ended in the same way in all conditions and trial types. After E2 went back to her initial position, E1 indicated the toy's location by pointing towards the empty bucket, using the same pointing gesture as in the baseline trials.

***Filler.*** The first test trial was followed by two filler trials that followed the same procedure as the baseline trials. Filler trials aimed at reducing carry-over effects from one test trial to another. They were followed by the second test.

***Post-test.*** A post-test trial followed the second test trial. It was similar to the true belief test trial, except that E1 did not leave the room at all, and that she did not point to indicate the location of the toy. Instead, E1 positioned at the location from which she pointed during preceding trials, and she said: "*Find it!*" (without pointing) to encourage the participant to find the toy. Note that given that the post-test trial was modeled after the test trials, it varied across conditions and studies. For example, in the post-test trial of the high certainty condition, the buckets were swapped first, then the toy's location was revealed. In the post-test trial of the low certainty condition, the toy's location was revealed, and then the buckets were swapped. Two participants enrolled in the high certainty condition (one 15-month-old, and one 24-month-old) refused to participate in the post-test trial. Given that they completed the key segments of the experiment they were kept in the main analysis.

**Design.** All participants were enrolled in one true belief trial and in one false belief test trial (order of presentation counterbalanced across participants). Whether the toy was hidden under the bucket located to the left or to the right of the participant was counterbalanced across participants. The toy's hiding location during the successive trials of the experiment followed the general structure ABBABBABA, where A stands for right side and B for left side for half of the participants (order 1), and A stands for left side and B for right side for the other half of the participants (order 2, see Table S4). In order 1, test trial 1 was a false belief test trial, and test trial 2 was a true belief test trial. In order 2, it was the opposite.

**Coding.** The coding procedure was the same for all Studies. For each trial, we considered that participants found the toy if they lifted first the bucket containing the toy. The first author coded the data. Twenty-five percent of the data was also randomly selected and coded again by a second coder unaware of the hypotheses of the study (baseline: average *kappa* = .94, range = .84 to 1; test: average *kappa* = 1; post-test: average *kappa* = 1). All disagreements between coders were resolved by discussion. Data analysis was conducted on the data from the first coder, except for trials in which there was a disagreement between coders. In these cases, the score that two coders agreed upon after discussion was kept in the analysis.

**Data analysis.** We followed the recommendations of Bergmann, Ludbrook, and Spooren (2000), and ran the Mann-Whitney-U test by compiling the null distribution of the rank-sum statistic by exact permutations. Hierarchical Bayesian ANOVAs were conducted using R (version 3.4.3), with the 'BANOVA' package (version 1.1.1; Dong & Wedel, 2017), with the number of successes in finding the toy treated as a binomial response variable and using a logit link and a normal heterogeneity distribution.

**Results**

Detailed descriptive statistics for Studies 1-4 are reported in Table S1-3. An analysis including the two age groups and the two conditions of Study 1 ($N = 64$) indicated that participants found the toy more often than predicted by chance during baseline trials ($W_+ = 1170$, $r = .96$, $p < .001$, one-sample Wilcoxon test) and during the post-test trial ($p = .003$, binomial test). Thus, participants were able to use both pointing (baseline) and their memory (post-test) to locate the toy. Moreover, 15- and 24-month-olds were comparable in their likelihood to find the toy during baseline trials ($U = 496$, $r = -.06$, $p = 1$, Mann-Whitney U test) and during post-test trials ($p = 1$, Fisher's exact test). Therefore, age had no detectable impact on participants' capacity to follow pointing, or on their capacity to memorize the toy's location.

During baseline trials, participants did not find the toy more often in the high certainty condition than in the low certainty condition (*U* = 464, *r* = -.17, *p* = .355, Mann-Whitney U test). Conversely, as expected, participants found the toy more often during the post-test trials in the high certainty condition than in the low certainty condition (*OR* = 1.16, *p* < .001, Fisher's Exact test), thus confirming that the difficulty to memorize the toy's location varied across conditions.

## Study 2

### Method

**Participants.** In addition to the 32 participants who constituted our sample (16 in each age group), 3 participants were excluded because of experimental error (1 15-month-old, and 2 24-month-olds), 11 for refusing to play/search or becoming fussy (7 15-month-olds, and 4 24-month-olds), 1 15-month-old), side bias and 7 for failure to understand the game (4 15-month-olds, and 3 24-month-olds).

**Stimuli and procedure.** Study 2 followed the same procedure as the high certainty condition of Study 1, except that one side of the buckets used to hide the toy had a large transparent window (16 x 10 cm). During the warm-up, baseline and filler trials, the buckets' transparent window was turned away from the participants, thus making it impossible for them to see the toy. During test trials, buckets were oriented so that their transparent window faced the participant, thus allowing participants to see the buckets' content.

**Design.** Given that in this study we expected participants to succeed in finding the toy in the test trials (as they could see it through the bucket windows at the moment of search), we did not test them on a post-test trial. As a result, participants were tested on the following succession of trials: two warm-up trials, two baseline trials, one test trial, two filler trials, and one test trial. For all these trials, the toy's hiding location during the successive trials of the experiment was counterbalanced as in Study 1.

**Coding and Analysis.** In study 2, participants' choice of bucket was coded in the same manner as in Study 1. Additionally, in this study, we also coded participants' spontaneous corrective pointing during test trials, as it seemed to occur in quite some cases. To be included in the analysis, pointing had to occur during test trials, after the misleading pointing of the experimenter and before the participant raised one of the buckets. Pointing was defined as extending a finger in the direction of one of the buckets and was considered to last until the finger was withdrawn. Pointing directed at the empty bucket -which was also the one the experimenter pointed at - were coded as "endorsements" while pointing directed at the bucket where the toy was were coded as "corrections". In one instance, it was not possible to determine towards which bucket the pointing was directed. This instance of pointing was not included in the analysis.

## Results

An analysis including all participants ($N$ = 32) revealed that in Study 2, participants found the toy more often than predicted by chance during baseline trials ($W_+ = 325$, $r = .85$, $p < .001$). Age (15- vs. 24-month-olds) had no effect on performance during baseline trials ($U = 136$, $r = .07$, $p = 1$, Mann-Whitney U test). The main analysis of the search behavior during the test trials is presented in the main text. Additional analyses revealed that 15-month-olds did not find the toy significantly more often than 24-month-olds during test trials ($U = 114$, $r = -.14$, $p = .653$, Mann-Whitney U test). Similarly, participants did not find the toy significantly more often during the false belief test trials than during the true belief test trials (2 participants found the toy during the false belief trial and did not find the toy during the true belief trial, 3 did the opposite, $p = 1$, McNemar’s test).

***Spontaneous pointing.*** During the test trials of Study 2, many participants pointed themselves towards one of the buckets after E1 pointed towards the empty bucket. To analyze these behaviors, we coded each instance of a participant’s pointing that took place during test trials from the moment E1 finished pointing, until the participant raised one of the buckets. During that time window, participants always pointed towards the baited bucket (9 participants pointed towards the baited bucket, but not towards the empty bucket, 0 did the opposite, $p$ = .008, McNemar’s test). Therefore, participants seemed to correct the misleading pointing of the experimenter, by indicating the correct location of the toy. In an exploratory unplanned analysis, we also looked at the effect of Belief (true vs. false belief test trial) to investigate whether participants’ corrections were different when the experimenter had a false belief about the location of the toy. Participants tended to point for longer durations towards the baited bucket during false belief test trials ($M$ = 1.19 s) than during true belief test trials ($M$ = .17 s, $W_+$ = 42.5, $r$ = .42 *Bonferroni-adjusted* $p$ = .031, Wilcoxon test for matched pairs; 8 toddlers pointed for a longer duration towards the baited bucket during false belief trials than during true belief trials, 1 did the opposite, *Bonferroni-adjusted* $p$ = .09, McNemar’s test). Thus, our participants sustained their corrective pointing longer when this correction could effectively change the mental states of the experimenter (i.e., when she did not see yet that the toy’s location had changed).

## Study 2A

This study investigated the limits of toddlers’ acceptance of the information conveyed by pointing, in addition to Study 2. For example, according to theories inspired by Spinoza, to understand what someone communicates requires first to accept it as true, only to reject it later if necessary (Gilbert, Krull & Malone, 1990). If this hypothesis were right, one possible source for toddlers' strong trust would be an inability to "un-accept" what they previously accepted automatically through the process of interpretation. This view predicts that toddlers' trust should be insensitive to the quality of evidence that they possess. Alternatively, toddlers' trust may originate from forming expectations about the extent to which communicated information can be relied upon. This second hypothesis predicts that toddlers should follow pointing less if they have better evidence that they can pit against it.

Study 2A used a procedure comparable to the one of Study 1, but in which participants had better evidence about the toy's location. During the test trials of Study 2A, the second experimenter (E2) displaced the toy in full view of the participants (instead of swapping the buckets), thus making it easier to track the toy's displacement. Moreover, E2 lifted up the two buckets sequentially, thus showing not only in which bucket the toy was but also that the other bucket was empty (unlike in Study 1, where participants only saw where the toy was). If toddlers automatically accept what is communicated to them, the quality of evidence that they can pit against pointing should make little difference. Toddlers' reliance should remain as strong in Study 2A than in Study 1.

**Method**

**Participants.** Sixteen 15-month-olds (*M* = 471 days, *range* = 460-479 days, *SD* = 6.53 days), and 16 24-month-olds (*M* = 741 days, *range* = 727-753 days, *SD* = 9.01 days) participated in this study. In addition to these 32 participants, 2 participants were excluded because of experimental error (1 15-month-old, and 1 24-month-old), 3 24-month-olds for fussiness, 1 24-month-old for a failure to understand the game and 1 15-month-old because of a technical failure.

**Stimuli and procedure.** The stimuli, materials, and procedure were identical to those used in Study 1, except for the way the toy's location was changed during test and post-test trials. Instead of swapping the location of the buckets, E2 transferred the toy from one bucket to the other, in full view of the participant. She first lifted up the baited bucket and picked up the toy, before placing the toy on the ground next to the second bucket. Next, she hid the toy by covering it with the second bucket. One 15-month-old enrolled in the Study S1 refused to participate in the post-test trial but was kept in the analysis, given that she participated in the key segments of the Study.

**Results**

For detailed descriptive statistics for performance in Study 2A, see Table S1,2. An analysis including the two age groups of Study 2A ($N$ = 32) indicated that participants found the toy more often than predicted by chance during baseline trials ($W_+ = 91$, $r = .93$, $p < .001$, one-sample Wilcoxon test) and during post-test trials ($p = .003$, binomial test). During test trials, participants did not find the toy less often than predicted by chance, unlike in Study 1 ($W_+ = 70$, $r = -.20$, $p = .359$, one-sample Wilcoxon test). Since the primary goal of Study 2A was to investigate whether the quality of evidence could modulate participants' trust in pointing, we compared performance in Study 2A, and in Study 1.

Study 1's participants did not find the toy significantly less often than Study 2A's participants during baseline trials ($U = 1072$, $r = .07$, $p = .713$, Mann-Whitney U test) or during post-test trials ($OR = 1.15$, $p = .471$, Fisher's exact test). Yet, during test trials, participants found the toy significantly less often in Study 1 than in Study 2A ($U = 694$, $r = -.30$, $p = .003$, Mann-Whitney U test). This result is in line with the results of Study 2 (reported in the main text). It confirms that the participants did not follow pointing in Study 1 just because they were unable to resist accepting what was communicated to them. Rather, our participants' reliance on pointing is reduced when it is contradicted by sufficiently strong counter-evidence.

As in Study 1, 15-month-olds' tended to find the toy more often than 24-month-olds during test trials ($U = 178$, $r = .35$, $p = .060$, Mann-Whitney U test). Only older participants found toy less often than expected by chance during test trials ($W_+ = 33$, $r = .16$, $p = .754$ for 15-month-olds, $W_+ = 5$, $r = -.58$, $p = .039$ for 24-month-olds, one-sample Wilcoxon tests). These results confirm the development of reliance on pointing observed in Study 1. However, unlike in Study 1, the developmental effect observed during test trials was not significant when analyzing separately performance during false belief trials or during true belief trials (respectively $OR = .26$, $p = .149$ and $OR = .35$, $p = .286$, Fisher's exact test), presumably because of a smaller sample size.

An analysis comparing performance in Studies 1 and 2A for each age group separately yielded the same pattern of statistically significant trends as analyses performed over the whole group of participants. Study 1's 15-month-olds did not find the toy significantly less often than Study 2A's 15month-olds during baseline trials ($U = 280$, $r = .13$, $p = .648$, Mann-Whitney U test) or during post-test trials ($OR = 1.30$, $p = .747$, Fisher's exact test). Similarly, Study 1's 24-month-olds did not find the toy significantly less often than Study 2A's 24-month-olds during baseline trials ($U = 256$, $r = 0$, $p = 1$ Mann-Whitney U test) or during post-test trials ($OR = 1.77$, $p = .505$, Fisher's exact test). Yet, during test trials, both age groups tended to find the toy significantly less often in Study 1 than in Study 2A ($U = 180$, $r = -.26$, $p = .078$, for 15-month-olds and $U = 158$, $r = -.41$, $p = .005$ for 24-month-olds, Mann-Whitney U tests). Study 2A confirms that toddlers' strong trust in pointing is not unconditional. It can be reduced if toddlers possess sufficiently strong evidence that they can pit against pointing.

## Study 3

### Method

**Participants.** In addition to the 32 participants who constituted our sample (16 in each age group), 15 participants were excluded because of fussiness/refusing to finish the game (12 18-month-olds, and 3 24-month-olds), 2 for experimental error (1 18-month-old, and 1 24-month-old), and 7 for failure to understand the game (6 18-month-olds, and 1 24-month-old).

**Stimuli and procedure.** The procedure of Study 3 was identical to the procedure of Study 1's high certainty condition, except that E1 communicated by placing a marker on top of a bucket, instead of pointing. When she manipulated the marker, E1 sat on a children's chair placed behind the two buckets (from the participants' viewpoint), at equidistance of them. Before placing the marker on top of a bucket, E1 showed it to the child by holding it with her right hand at the level of her eyes, while saying: "*Look!*". She then placed the marker on top of the baited bucket, and she encouraged the child to find the toy by saying: "*Where is the dog? Find it!*". As in Study 1, the sentence « *Find it!* » was the cue for caregivers to let participants approach the buckets.

**Design.** Study 3 started with four warm-up trials (instead of two in Studies 1 and 2) to ensure that our participants would have enough experience with the marker to be able to interpret it. We also added two additional test trials at the end of the procedure (one true belief trial, one false belief trial, order of presentation counterbalanced across participants). Thus, participants were presented with four warm-up trials, two baseline trials, one test trial, two filler trials, one test trial, one post-test trial, and two further test trials. We counterbalanced the side of the bucket hiding the toy (left or right) within participants for warm-up trials and baseline trials, and across participants during the test trials and post-test trials. To do so, the bucket in which the toy was hidden in the successive trials of the experiment followed the general structure ABBAABAABABBB, where A stands for right side and B for left side for half of the participants (order 1), and A stands for left side and B for right side for the other half of the participants (order 2, see Table S5). In order 1, test trials 1 and 3 were false belief test trials, and test trials 2 and 4 were true belief test trials. In order 2, it was the opposite.

## Results

An analysis including all the age groups in Study 3 ($N$ = 32) indicated that participants found the toy more often than predicted by chance during baseline trials ($W_+$ = 325, $r$ =.90, $p$ < .001, one-sample Wilcoxon test) and during post-test trials ($p$ = .02, binomial test). Therefore, participants were able to use the marker and their memory to locate the toy. Eighteen-month-olds did not find the toy significantly more often than 24-month-olds during baseline trials ($U$ = 112, $r$ = -.16, $p$ = .653, Mann-Whitney U test), and during post-test trials ($OR$ = 1.36, $p$ = 1, Fisher's exact test). Therefore, the two age groups were comparable in their capacity to follow the novel communicative cue and to memorize the toy's location. The detailed analysis of performance during the test trials is presented in the main text.

# Study 3A

In Study 3A, we probed further the role of experience in shaping toddlers' trust. This Study followed the same procedure as Study 3, except that we reduced the number of trials preceding the first test. As a result, participants had very limited evidence about the reliability of the marker.

## Method

**Participants.** 16 24-month-old toddlers participated in the study (*Mean age* = 745 days, *range* = 731-760 days,). In addition, 8 participants were excluded because of fussiness, 1 for parental interference, and 1 for failure to understand the game.

**Stimuli and Procedure.** Study 3A followed the same procedure as Study 3, except that we reduced the number of trials preceding the first test. Participants were enrolled in the following succession of trials: two warm-up trials (in which the toy was hidden visibly), a single baseline trial, a test trial, two filler trials, a test trial, a post-test trial, and two test trials.

**Design.** We counterbalanced the side of the bucket hiding the toy (left or right) within participants for warm-up trials and baseline trials, and across participants during test trials and post-test trials. To do so, the bucket in which the toy was hidden in the successive trials of the experiment followed the general structure ABBAABABBB where A stands for right side and B for left side for half of the participants (order 1), and A stands for left side and B for right side for the other half of the participants (order 2, see Table S6).

## Results

For detailed descriptive statistics for performance in Study 3A, see Table S1,3. Participants found the toy less often than predicted by chance during test trials ($W_+ = 7$, $r = -.69$, $p = .003$, one sample Wilcoxon test). Remarkably, participants found the toy less often than predicted by chance even in the very first test trial (2 participants found the toy out of 16, $p = .004$, binomial test). Therefore, toddlers relied on the marker over their memory even after participating in a single baseline trial.

We evaluated whether the amount of experience with the marker could have an effect on participants' trust in two ways. First, we tested the effect of experiencing that the marker was repeatedly reliable. We performed this assessment by comparing performance in Studies 3 and 3A, that differed in the number of trials in which the marker was reliable. During test trials, participants did not find the toy significantly more often in Study 3 than in Study 3A, regardless of whether we analyzed data for all test trials ($U$ = 127, $r$ = -.01, $p$ = .963, Mann Whitney U test), or for the first test trial only ($p$ = 1, Fisher's exact test). Therefore, experiencing (a few) more trials in which the maker was reliable did not increase participants' reliance on the marker. This result is consistent with the view that participants' trust in the marker placed communicatively was initially high, and perhaps at ceiling (and thus not increased by more evidence about the marker's reliability).

Second, we tested the effect of experiencing that the marker was repeatedly unreliable. To do so, we compared reliance on the marker during the first test trial (that was preceded only by trials in which the marker was reliable), and during the last test trial (that followed three test trials in which the marker was unreliable) in Studies 3 and 3A pooled together. Twenty-four-month-olds found the toy more often during the last test trial than during the first test trial (that is they followed the marker less in the last trial): Eight participants (3 in Study 3, 5 in Study 3A) found the toy during the last test but not during the first test, 1 participant (in Study 3) did the opposite ($p$ = .046, McNemar's test). Therefore, toddlers' initial reliance on the marker may be reduced to some extent if the cue proves repeatedly unreliable.

## Study 4

## Method

**Participants.** In addition to the 16 24–month-old participants who constituted our sample, 5 participants were excluded because of fussiness/refusing to finish the game, 1 for experimental error, and 4 for failure to understand the game.

## Results

In Study 4 participants found the toy more often than predicted by chance during baseline trials ($W_+ = 78$, $r = .87$, $p < .001$, one-sample Wilcoxon test), thus confirming their capacity to find the toy using the marker. By contrast, and unlike in our previous studies, participants did not find the toy more often than predicted by chance during post-test trials ($p = 1$, binomial test). We have no definitive explanation for this lack of effect in the post-test. Importantly, however, participants enrolled in Study 4 demonstrated their capacity to memorize the location of the toy through their performance during test trials (cf. main manuscript).

In order to evaluate whether the communicative use of the marker had an effect on participants' trust, we compared performance in Studies 3 (communicative use of the marker), and 4 (non-communicative use of the marker). Study 3's participants did not find the toy significantly more often than Study 4's participants during the baseline trials ($U = 144$, $r = .16$, $p = .654$, Mann-Whitney U test), or during the post-test trial ($OR = .33$, $p = .273$, Fisher's exact test). However, there was a significant effect of Study (3 vs. 4) on performance during the test trials (see detailed analysis in the main text), thus suggesting that 24-month-olds' reliance on the cue was stronger when it was used in a communicative manner.

# Study 4A

In Study 4, when E2 lifted the bucket to reveal the location of the toy, participants could already see that the marker was placed on the other bucket. By contrast, they did not have this extra piece of information in Study 3. We controlled for this difference in an additional Study 4A.

## Method

**Participants.** Sixteen 24-month-olds participated in the Study (mean age = 744 d; range = 733–761 d). In addition, 8 participants were excluded because of fussiness, 1 for experimental error, 5 for failure to understand the game, and 1 for parental interference.

**Stimuli and procedure.** Study 4A followed the same procedure as Study 3, except that during the test trials, after hiding the toy, E1 ostensively placed the marker on top of the empty bucket right after the screen was removed, before pretending to receive a phone call and leaving the room. Therefore, the marker was already placed on the bucket when E2 swapped the buckets' locations and revealed the location of the toy.

## Results

For detailed descriptive statistics for performance in Study 4A, see Table S1,3. In Study 4A, participants tended to find the toy more often than predicted by chance during baseline trials ($W_+$ = 406, $r$ = .93, $p$ < .001, one sample Wilcoxon test) and during post-test trials ($p$ = .08, binomial test), confirming their capacity to rely on the marker and on their memory to find the toy.

To evaluate the effect of signals indicating an intention to communicate, we compared performance in Studies 4A (communicative use of the marker) and in Study 4 (non-communicative use of the marker). Study 4A's participants did not find the toy significantly more often than Study 4's participants during the baseline trials ($U$ = 96, $r$ = .37, $p$ = .101, Mann-Whitney U test), or during the post-test trial ($OR$ = .33, $p$ = .273, Fisher's exact test). Performance during test trials showed a different pattern across Studies (4A vs. 4, $U$ = 56, $r$ = -.49, $p$ = .005, Mann-Whitney U test). Participants found the toy significantly more often than predicted by chance in Study 4 ($W_+$ = 73, $r$ = .54, $p$ = .046, one sample Wilcoxon test), but not in Study 4A ($W_+$ = 22, $r$ = -.34, $p$ = .199, one sample Wilcoxon test). These results confirm that cues signaling an intention to communicate increase toddlers' reliance on a novel communicative signal.

### Analysis of the Effect of Order of Presentation (True vs. False Belief Trial First)

In a complementary exploratory analysis suggested by an anonymous reviewer, we assessed the effect of the order of presentation of belief conditions (true belief first vs. false belief first) on children's performance in Studies 1 and 3. For Study 1, we conducted a hierarchical Bayesian ANOVA on success in finding the toy, with Belief (true vs. false belief trial) as a within-subject variable, and with Age (15- vs. 24-month-olds) and Order of presentation (True vs. False belief first) as between-subject variables. This analysis revealed a main effect of Age ($\eta_p^2$ = .58; $p$ < .001), and an interaction between Belief and Age ($\eta_p^2$ = .50; $p$ = .03). The analysis revealed no other significant effects. In particular, the effect of Order of presentation was not significant ($\eta_p^2$ = .34; $p$ = .12). For Study 3, we conducted a hierarchical Bayesian ANOVA on success in finding the toy, with Belief (true vs. false belief trial) as a within-subject variable, and with Age (18- vs. 24-month-olds) and Order of presentation (True vs. False belief first) as between-subject variables. This analysis revealed an interaction between Belief and Age ($\eta_p^2$ = .61; $p$ = .013). This analysis revealed no other significant effects. In particular, the effect of Order of presentation was not significant ($\eta_p^2$ = .35; $p$ = .10).

## Discussion of The Effect of Trust on Interactive Tests of Toddlers' Representation of Beliefs

In a seminal study by Southgate, Chevallier and Csibra (2010), tested seventeen-month-old infants' capacity to rely on representations of beliefs to interpret communicated information. The participants were first familiarized with a first experimenter who placed two familiar objects in two different boxes, in full view of the child. During several warm-up trials, the experimenter asked the child to pick up one of the two familiar objects, followed by the other one. Thus, during the warm-up phase, infants learned that the first experimenter communicated the identity of the object that she wanted the child to pick up. In the test phase, the first experimenter placed two unfamiliar unnamed objects in two separate boxes and left. While she was away, a second experimenter switched the objects so that they were each now in opposite boxes. In the false-belief conditions, the first experimenter returned to the room, apparently ignorant of the fact that another person had been there, and pointed to one of the two (closed) boxes, while asking for what was inside it. The true belief conditions were identical to the false belief conditions, except that the first experimenter was present in the room and watched as the second experimenter displaced the objects. Seventeen-month-old infants tended to search for the object in the box pointed at by the experimenter in the true belief conditions, while they tended to search in the box that was *not* pointed at in the false belief conditions. These data are important, because they suggest that from a very early age, infants rely on representations of what people believe when interpreting what they communicate. However, some studies seem to replicate these results and some others do not (Doerrenberg et al., 2018; Király et al., 2018; Wenzel et al., 2020).

In our studies, we find that the tendency to rely on ill-informed adults' communicative cues increases during the second year of life in Studies 1 and 3. This result suggests that as infants grow older, their tendency to rely on communicative cues may gradually mask their capacity to monitor others' epistemic states. This hypothesis predicts that in experiments comparable to the one of Southgate et al., infants' tendency to follow the pointing gestures of informants with a false belief might decrease as they grow older. To assess this conjecture, we retrieved data from four studies using Southgate et al.'s task with participants under three years of age ($N$ = 264, age range = 17-30 months, Dörrenberg et al., 2018; Király et al., 2018; Southgate et al., 2010; Wenzel et al., 2020). We entered the participants' performance on the first test trial in a binary logistic regression, with Age (in month) as a continuous co-variate, and Belief (True vs. False) as a factor. The results revealed a main effect of age ($\beta$ = .22, $z$ = 4.99, $p$ < .001) indicating that the participants were more likely to follow the experimenter's cue as they grew older. The analysis also showed a main effect of belief ($\beta$ = 4.16, $z$ = 2.88, $p$ = .004), indicating that the participants followed the experimenter's cue less often in the false belief condition than in the true belief condition. Third, the analysis showed an interaction between Belief and Age ($\beta$ = -.14, $z$ = -2.16, $p$ = .031), indicating that the effect of Age on children's trust in the communicative cue was stronger in the false belief condition than in the true belief condition. Thus, this analysis of earlier studies in in line with the results of Studies 1,3. Moreover, this analysis suggests that the development of epistemic trust may contribute to explain why 24-month-old and 30-month-old participants disregard informants' beliefs in studies using Southgate et al.'s paradigm.

**Table S1.** Performance during baseline, test and post-test trials for each Study, Age group, and Condition

| | Baseline | | | Test | | | Post test | |
|---|---|---|---|---|---|---|---|---|
| | *n* | % of trials in which participants found the toy | | *n* | % of trials in which participants found the toy | | *n* | number of participants who found the toy |
| | | Mean [95% CI] | Mdn | | Mean [95% CI] | Mdn | | |
| Study 1 | | | | | | | | |
| all participants | 64 | 96 [93, 98] | 100 | 64 | 20 [13, 27] | 0 | 62 | 43 |
| 15-month-olds | 32 | 95 [90, 98] | 100 | 32 | 34 [22, 45] | 25 | 31 | 21 |
| 24-month-olds | 32 | 97 [91, 98] | 100 | 32 | 6 [2, 12] | 0 | 31 | 22 |
| high certainty | 32 | 94 [87, 94] | 100 | 32 | 22 [11, 31] | 0 | 30 | 29 |
| low certainty | 32 | 98 [93, 99] | 100 | 32 | 19 [9, 28] | 0 | 32 | 14 |
| Study 2 | | | | | | | | |
| all participants | 32 | 89 [78, 94] | 100 | 32 | 89 [78, 94] | 100 | - | - |
| 15-month-olds | 16 | 91 [80, 95] | 100 | 16 | 87 [68, 94] | 100 | - | - |
| 24-month-olds | 16 | 87 [77, 92] | 100 | 16 | 91 [72, 97] | 100 | - | - |
| Study 3 | | | | | | | | |
| all participants | 32 | 90 [84, 94] | 100 | 32 | 32 [23, 41] | 25 | 32 | 23 |
| 18-month-olds | 16 | 87 [77, 92] | 100 | 16 | 42 [28, 55] | 50 | 16 | 11 |
| 24-month-olds | 16 | 93 [84, 97] | 100 | 16 | 22 [11, 34] | 0 | 16 | 12 |
| Study 4 | | | | | | | | |
| 24-month-olds | 16 | 88 [77, 92] | 100 | 16 | 72 [55, 81] | 75 | 16 | 8 |
| SI Studies | | | | | | | | |
| Study 2A | | | | | | | | |
| all participants | 32 | 94 [87, 96] | 100 | 32 | 42 [30, 53] | 50 | 31 | 24 |
| 15-month-olds | 16 | 91 [81, 95] | 100 | 16 | 56 [34, 69] | 50 | 15 | 11 |
| 24-month-olds | 16 | 97 [86, 98] | 100 | 16 | 28 [12, 41] | 25 | 16 | 13 |
| Study 3A | | | | | | | | |
| 24-month-olds | 16 | 100 | 100 | 16 | 23 [12, 34] | 12.5 | 16 | 14 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Study 4A | | | | | | | | |
| 24-month-olds | 16 | 100 | 100 | 16 | 41 [27, 52] | 37.5 | 16 | 12 |

**Table S2.** Patterns of individual performance during test trials for Studies 1, 2, and 2a.

| | | Study 1 | | Study 2 | | Study 2a | |
|---|---|---|---|---|---|---|---|
| | | 15-mo-olds | 24-mo-olds | 15-mo-olds | 24-mo-olds | 15-mo-olds | 24-mo-olds |
| Number of trials in which the participant found the toy (out of 2) | 0 | 16 | 28 | 0 | 1 | 4 | 8 |
| | 1 | 10 | 4 | 4 | 1 | 6 | 7 |
| | 2 | 6 | 0 | 12 | 14 | 6 | 1 |

**Table S3.** Patterns of individual performance during test trials for Studies 3, 3a, 4, and 4a.

| | | Study 3 | | Study 3a | Study 4 | Study 4a |
|---|---|---|---|---|---|---|
| | | 18-mo-olds | 24-mo-olds | 24-mo-olds | 24-mo-olds | 24-mo-olds |
| Number of trials in which the participant found the toy (out of 4) | 0 | 4 | 9 | 8 | 2 | 2 |
| | 1 | 2 | 2 | 4 | 0 | 6 |
| | 2 | 6 | 4 | 2 | 3 | 4 |
| | 3 | 3 | 0 | 2 | 4 | 4 |
| | 4 | 1 | 1 | 0 | 7 | 0 |

**Table S4. Toy's hiding location in each trial of Study 1.** For test and post-test trials, right and left refer to the initial hiding location, before the buckets' locations were swapped.

| | warm up1 | warm up2 | baseline 1 | baseline 2 | test 1 | filler 1 | filler 2 | test 2 | post test |
|---|---|---|---|---|---|---|---|---|---|
| order 1 | right | left | left | right | left | left | right | left | right |
| order 2 | left | right | right | left | right | right | left | right | left |

**Table S5. Toy's hiding location in each trial of Study 3.** For test and post-test trials, we report the initial hiding location, before the buckets' locations were swapped.

| | warm up 1 | warm up 2 | warm up 3 | warm up 4 | base-line 1 | base-line 2 | test 1 | filler 1 | filler 2 | test 2 | post test | test 3 | test 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| order 1 | right | left | left | right | right | left | right | right | left | right | left | left | left |
| order 2 | left | right | right | left | left | right | left | left | right | left | right | right | right |

**Table S6. Toy's hiding location in each trial of Study 3A.** For test and post-test trials, we report the initial hiding location, before the buckets' locations were swapped.

| | warm up 1 | warm up 2 | baseline 1 | test 1 | filler 1 | filler 2 | test 2 | post test | test 3 | test 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| order 1 | right | left | left | right | right | left | right | left | left | left |
| order 2 | left | right | right | left | left | right | left | right | right | right |

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