Fourteen-month-olds selectively search for and use information depending on the familiarity of the informant in both laboratory and home contexts

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Abstract

Infants are selective in their learning from others. However, there is only very limited research on the possible factors that shape this selectivity, especially when it comes to the impact of infants’ familiarity with the informant and the context. The current study investigated whether 14-month-olds preferred to receive and use information provided by an unfamiliar informant (experimenter) compared with a familiar informant (parent) and whether this pattern depended on the context (home vs. laboratory). We tested infants either in the laboratory (n = 67) or in their home (n = 70). When both informants presented a novel object with positive or negative emotions, we measured infants’ gaze behavior as an indicator for information search. When infants acted on the novel object themselves, we measured their exploratory behavior as an indicator of information use. Results revealed no effect of context on infants’ information search and use. Rather, we found that the familiarity of informant had distinct effects on infant attention and object exploration. Namely, infants looked longer at the unfamiliar informant across contexts, but they explored more when the familiar informant presented the object compared with when the unfamiliar informant did so. Thus, during information search, 14-month-olds paid most attention to an unfamiliar source of

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information. However, participants explored the objects more when they came from a familiar source than when they came from an unfamiliar one. Possible explanations for these findings are discussed.

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Introduction

Infants’ social environment is of special importance for their social and cognitive development given that much of the new information they encounter is provided by other people. In the field of cognitive development, the study of infants’ social referencing investigates infants’ abilities to gather information from others in novel or ambiguous situations (Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992; Hornik, Risenhoover, & Gunnar, 1987; Stenberg, 2009). An important and well-known challenge for research in this area is aptly characterizing and explaining the functions of infant social referencing behaviors across a broad range of environments and situations (Baldwin & Moses, 1996; Klinnert, Campos, Sorce, Emde, & Svejda, 1983). Infants’ referencing behaviors often occur in new situations where infants are confronted with more than one informant of varying familiarity to the infants. For example, when infants face a novel object they have never seen before and are uncertain about how to evaluate it, they may have access to multiple sources of information about it. Here we asked the question: Who do infants attend to, and whose information do they use?

Recent research on early social learning demonstrates that infants make certain distinctions among informants; they prefer to look for and use information provided by certain informants over others (Birch, Vauthier, & Bloom, 2008; Chow, Poulin-Dubois, & Lewis, 2008; Corriveau & Harris, 2009; Koenig & Echols, 2003; Koenig & Sabbage, 2013; Zmyj, Buttelmann, Carpenter, & Daum, 2010; for reviews, see Harris & Lane, 2013; Lucas & Lewis, 2010). For instance, 14-month-olds followed the gaze of a reliable experimenter to a hidden object but did so less if presented with an unreliable experimenter (Chow et al., 2008). Infants are surprised by inaccurate emotional signalers whose emotion displays (e.g., sadness) are inconsistent with events they refer to (e.g., receiving a desirable toy) (Chiarella & Poulin-Dubois, 2015; Hepach & Westermann, 2013; Skerry & Spelke, 2014). Results from studies using the social referencing paradigm also reveal infants’ selective judgments. For example, when facing an ambiguous toy and two experimenters who provided information about the toy but differed in their levels of demonstrated expertise, 12-month-olds looked more at the “expert” than at the “non-expert” during the information phase. They also used this information (i.e., played with the toy) more when the toy was presented by the expert rather than by the non-expert (Stenberg, 2012, 2013). However, such effects might be explained by infants’ familiarity with the expert who interacted with the children before the study, in contrast to the non-expert who did not. Therefore, it remains unclear whether infants’ preference for the expert was affected by the familiarity of the source or by the experimenter’s expertise.

Familiar and unfamiliar informants

Other studies using the same paradigm demonstrate that infants’ search for and use of information is influenced by their familiarity with the informants. For example, when presented with a provocative object (e.g., a toy spider) and happy or fearful emotional information provided by either a familiar informant or an unfamiliar informant (i.e., mother–happy, mother–fearful, stranger–happy, or stranger–fearful), 14-month-olds responded differently to the emotions that were displayed by their mother (Zarbatany & Lamb, 1985), not by the stranger. In contrast to this, other studies have found that 12-month-olds look more at, and use more information from, an unfamiliar informant over a familiar informant when facing an ambiguous object (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). For example, in Stenberg’s (2009) and Stenberg and Hagekull’s (2007)
studies, a familiar person (i.e., the infants' parent) or an unfamiliar person (i.e., the experimenter) presented an ambiguous toy to infants and provided emotional information about this toy while measuring infants' looking time at the informants. The authors found that infants looked longer at the unfamiliar person than at the familiar one and played more with the toy when it had been presented by the unfamiliar person. Such findings are consistent with an expertise account, as discussed by Stenberg (2009); in the unfamiliar context of the laboratory, an unfamiliar person who seems familiar with the lab context may be perceived as a reliable information source.

So far, however, the empirical findings remain open to other interpretations. Infants often look at unfamiliar informants in social referencing situations, and it can be unclear why they do so (Aslin, 2007; Vaish & Striano, 2004; Walden & Baxter, 1989). One possible explanation is that infants' heightened attention to unfamiliar agents is due to the limited but specific exposure infants are given to that person in the lab setting. For example, infants have been presented with variably unfamiliar experimenters not only who presented cues to expertise in the laboratory such as opening the doors, showing the family where to sit (Stenberg, 2012), and handling objects competently (Stenberg, 2013) but also who became more familiar to the infants during the process. Here, to better investigate the roles of familiarity and context in infants' social referencing, we carefully controlled infants' exposure to unfamiliar informants across two contexts: the unfamiliar context of the laboratory and the familiar contexts of the infants' home. In comparison with previous studies, we also contrasted unfamiliar informants with familiar informants who have been familiar to infants over a longer period of their lives (i.e., infants' parents) in order to manipulate familiarity in its original meaning.

Another possibility is that infants' attention to unfamiliar informants reflects a more consistent preference for unfamiliar agents, one that infants might show across contexts more generally. Humans of all ages are known to direct their attention to novel individuals, items, and events (Itti & Baldi, 2006), and seeking novelty is believed to be central to learning and memory (Schultz & Dickinson, 2000). If infants' attention to unfamiliar informants is due to their general attention to novelty, then heightened attention to unfamiliar informants would be expected across contexts. However, the novelty of a context matters for infants' imitative learning behavior; for example, 12-month-olds imitated more often in a unique learning context than in one they had previously experienced (Jones & Herbert, 2008). Results like these suggest that context may play an important role in infants' social learning. However, studies on infant social referencing have not varied the learning context systematically, leaving it unclear how sensitive infants indeed are to where (teaching and) learning takes place. Because Stenberg and colleagues (Stenberg, 2009, 2012, 2013; Stenberg & Hagekull, 2007) did not assess infant social referencing outside of the lab context, the role of context in infants' appeal to unfamiliar informants needs further examination. To examine the role of context in infants' social referencing behavior, we varied the location of the study across the infants' home and the laboratory. These contexts differed not only in the location of the experiment but also in a variety of aspects surrounding the infants' learning behavior, including the room, objects, tables, walls, colors, and scents (see Stenberg, 2009, for a similar use of the term context). By examining infants attention across contexts, we documented whether infants' preferences for unfamiliar informants extends outside of the laboratory and aimed to substantiate conclusions about the influences that objects, persons and locations have on infants' attention.

Finally, to understand the meanings of infants' looks to unfamiliar informants, it was important to examine other infant behaviors such as their information use in object exploration. Infants' information use in social referencing situations points to a mixed set of findings; infants use information provided by familiar informants (Zarbatany & Lamb, 1985), unfamiliar informants (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005), or some combination of familiar and expert informants (Stenberg, 2012, 2013). Because such questions have mainly been tested in the laboratory, where infants faced only a single informant (i.e., the parent or the experimenter) in most studies, the selective effects of familiarity on infants' information use remain unclear. In the current study, we presented infants with both the experimenter and the parent simultaneously, taking care to measure infants' looking preferences as distinct from their exploratory actions on objects. This design allowed us to examine infants' looking preferences independent of their object exploration to examine the possibility that informant knowledge and familiarity may have distinct effects on infant looking and exploration.
Positive and negative emotions

There is much evidence that infants between 12 and 14 months of age regulate their behavior in accordance with the emotional information displayed by their mother (e.g., Carver & Vaccaro, 2007; Hertenstein & Campos, 2004; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme, Fernald, & Herrera, 1996; Saarni, Campos, Camras, & Witherington, 2006). That is, infants approach a novel object or person when their mother displays positive emotions, and they refuse to do so when their mother displays negative emotions. There is additional evidence for 12- to 18-month-old infants’ ability to use emotions when displayed by even an unfamiliar individual (de Rosnay, Cooper, Tsigaras, & Murray, 2006; Klinnert, 1984; Klinnert, Emde, Butterfield, & Campos, 1986; Moses et al., 2001; Mumme & Fernald, 2003; Repacholi, 1998; Sorce, Emde, Campos, & Klinnert, 1985). In the study conducted by Repacholi (1998), for example, an unfamiliar experimenter expressed happy emotions while looking and putting her hand into one box and expressed disgust while looking and putting her hand into a second box. Results indicated that 14- and 18-month-old infants preferred to search the “happy emotion” box, meaning that both age groups understood the valence of the expressed emotions and correctly associated them with the content of the two boxes (see also Repacholi, 2009). Consequently, infants in their second year of life understand and make use of the directedness of emotional valences to certain events in their environment, which perfectly corresponds with studies indicating that infants start to follow others’ attentional focus to objects around their first birthday (Brooks & Meltzoff, 2002; Moll & Tomasello, 2004; Woodward, 2003).

However, almost nothing is known about how infants weigh emotional cues from both a familiar informant and an unfamiliar informant in direct comparison. Thus, it remains unclear whether the effects of emotions on infants’ information search and use depend on the person who presents them. The only exception, to the best of our knowledge, is a classical social referencing study in which both an unfamiliar experimenter and the participants’ mother displayed positive and negative emotions to 18- and 24-month-old participants in a within-participants design (Walden & Kim, 2005). The authors measured infants’ looking behavior to both sources and found that infants looked more frequently at the experimenter than at the mother and also looked more frequently when both informants presented negative emotions compared with when they presented positive emotions. This is consistent with the operation of a negativity bias during infancy (see Vaish, Grossmann, & Woodward, 2008, for a review). However, because infants were not given the chance to manipulate the target objects after the information search phase, the effect of negative emotions (from either the experimenter or the mother) on infants’ evaluations of objects remains unknown. Thus, to date, no social referencing study has directly examined emotional affect as it relates to the familiarity of informants within participants and whether such relations hold for both infants’ attention to human sources and their examination of the objects these sources provide.

In the current study, we examined 14-month-old infants’ performance in a social referencing task across two contexts: the laboratory and the infants’ home. Moreover, in both contexts, we presented infants with two sources of information: an unfamiliar informant (i.e., the experimenter) and a familiar informant (i.e., infants’ parent). Furthermore, we presented infants with two kinds of emotional information: positive and negative. This allowed us to determine how the familiarity of the informant influences infants’ use of emotional information when examining informants and objects. The systematic variation of the informant, the context, and the emotional cues reflects the advantage of the current design and, by distinguishing infants’ attention to the informants from their exploration of the objects, we aimed to both clarify and contribute to the study of infant social referencing. We decided to investigate infants at 14 months of age to be able to compare our results with previous social referencing studies and, in addition, to ensure that the participants possessed the attentional and motor abilities necessary to pass the social referencing task.

Given the empirical evidence from previous studies, we predicted three different but possible patterns of results. First, infants might look more at and explore more in accordance with the information provided by the unfamiliar informant across both contexts. Such a finding would be evidence for infants’ preference to look for and use information from unfamiliar informants. Second, infants might look more at and use information more from the familiar informant, possibly due to infants’ seeking safety and comfort in ambiguous situations or infants’ preference to look for and use information from
the familiar informant (perhaps because they consider the familiar informant a more reliable source of information). Third, infants’ social referencing behavior might depend on the context of the situation, as suggested by Stenberg (2009). This effect could be caused by associations infants form between a specific informant and the context in which information is presented. If correct, infants were expected to attend to and use the information provided by the familiar informant in their home and to attend to and use information provided by the unfamiliar informant in the lab context. Regarding the role of emotional expression, we expected infants to look more at the informants when they expressed negative emotions than when they expressed positive emotions (Walden & Kim, 2005). Moreover, in line with a possible negativity bias (Vaish et al., 2008), we anticipated that informants’ negative emotions would have a greater impact on explorative behavior than would informants’ positive emotions.

Method

Participants

The sample consisted of 137 infants aged 14 months (mean age = 14;1 [months;days], age range = 13;12–14;29; 68 girls). We tested 67 infants in the laboratory (mean age = 14;0, age range = 13;13–14;29; 33 girls) and 70 infants in their home (mean age = 14;2, age range = 13;12–14;24; 35 girls). In addition to the tasks reported here, infants also participated in a second session where we presented them with an imitation task (1-week delay; order of exploration and imitation tasks counterbalanced) reported elsewhere. Infants’ performance in the exploration task was independent of the order of tasks, so we analyzed the sample as a whole. An additional 3 infants were tested but excluded from the analyses due to fussiness. Participants were recruited from a database of parents who had agreed to participate in child development studies in a mid-sized German city. During each invitation call, we asked that the parent who was the infant’s primary caregiver accompany the infant to the laboratory. In addition to their general agreement, parents signed a consent form for their children’s participation in the current study prior to testing. This study was conducted in accordance with the ethical standards laid down in the Declaration of Helsinki and the standards of the local ethics committee of the University of Erfurt. All infants received a toy and a certificate for their participation.

Apparatus and stimuli

During the experiment, the infant sat in a chair fixed to a table. The parent and the experimenter sat at the left and right sides of the infant at the same table, opposite to each other. Next to the experimenter’s and parent’s chairs, there were small chairs with magazines and instruction sheets as reminders of the order and content of each trial. One camera was placed opposite the infant in order to record the infant’s gaze behavior and exploratory behavior. A second camera was placed behind the infant to record the infant’s exploratory behavior as well as the parent’s and experimenter’s acting. On each trial, the experimenter or parent (i.e., the informant) presented a specifically manufactured, and thus novel, exploration box (five boxes in total, each 28 cm wide, 15 cm deep, and 7 cm high; see Fig. 1) that contained different items (e.g., bubble wrap). While presenting a box, the informant provided positive or negative emotions (except for one neutral trial in which the assistant placed the box on the table, and neither informant provided emotional cues; see below).

Procedure

According to condition (laboratory vs. home, between participants), the experiment took place either in the laboratory or in the infants’ home. During a warm-up phase, the parent filled out a consent form and an assistant played with the infant. In the meantime, the experimenter (same male adult in both contexts) explained the procedure to the parent without mentioning any hypotheses of the study. While the assistant kept on playing with the infant in the warm-up room, both the parent and experimenter entered the testing room, they approached the testing apparatus, and the experimenter (out of the infant’s view) taught the parent the procedure. This was done because a pilot
Fig. 1. The five exploration boxes used as novel toys.
study revealed the necessity of acting out the procedure with the parent before the test in order to ensure the quality of the parent’s performance. After this training, the assistant and infant joined the experimenter and parent and the experiment started.

**Presentation phase**

Infants received four trials which systematically varied by informant (the experimenter or parent) and by emotional valence toward the box (positive or negative). On one trial, the experimenter presented a box and provided positive emotions; on another trial, he presented another box with negative emotions. On the other two trials, the parent presented another two boxes: on one trial with positive emotions and on the other trial with negative emotions. The positive emotions consisted of joyful and excited facial and verbal expressions (“Oh! What a funny thing!”), whereas the negative emotions consisted of disgusted and derogatory facial and verbal expressions (“Oh! What a strange thing!”). The parent was asked to display the prescribed emotions as she or he would naturally do in everyday interactions with the infant. At the beginning of each trial, the person who presented the box went out of the room, got the box, came back in, and took a seat at the table. The presentation phase started with the informant making the first comment (“Oh! What a funny thing!” with positive affect or “Oh! What a strange thing!” with negative affect) while holding the box in her or his hands and looking at it from different angles. Afterward, this informant placed the box in the middle of the table, out of the infant’s reach. The informant then looked at the box while making comments and displaying emotions in either a positive way (“Oh, this is nice! What a funny thing! Oh, I really like that!”) or a negative way (“This is weird! What a stupid thing! Ugh, I don’t like that!”). After the second and third comments, the informant looked at the infant for 5 s in order to maintain the infant’s attention (Csibra & Gergely, 2009). The person who did not present the box read a magazine during this phase and did not look at the infant (Stenberg, 2009). The rationale for having only one informant provide information instead of having both informants provide information in an individual trial was to reduce demands on infants’ limited attention and memory capacities. In addition to the four trials, which included emotional information, infants received a fifth trial (i.e., the neutral trial) in which both informants read magazines while the assistant placed the box on the table and neither the experimenter nor the parent made any comments about the box or provided emotional cues during the presentation phase. However, to maintain the infant’s attention and increase the comparability between the experimental trials, both informants shortly looked two times at the infant simultaneously at specific points of time (i.e., signaled by the experimenter having foot contact with the parent). This baseline condition ensured the investigation of both the infant’s looking behavior and his or her explorative behavior when no emotional information was provided.

**Action phase**

After the presentation phase, the presenting informant placed the box on a fixed tray within the infant’s reach. Both informants did this collaboratively in the neutral trial. From the moment the box was placed in front of the infant, the action phase started, and the infant had the opportunity to explore the box for 60 s (in pilot studies, this turned out to be a suitable period of time). In case the infant touched the box before it reached its final position, the trial started with the infant’s first touch. After the action phase, the assistant entered the room, took the exploration box, and the next trial started with the presenting person getting the next box. See Fig. 2 for an overview of the procedure of the study. After finishing the experiment, the experimenter, the assistant, the parent, and the infant went back to the play area, where the experimenter explained the hypotheses and ideas of the study to the parent. The experiment lasted approximately 15 min. The order of the five trials was counterbalanced by having 30 orders varying in the position of the neutral trial as well as the order of the presenting informants, left/right position of the informants, displayed emotions, and order of presented boxes between participants. Thereby, we ensured that each box was presented by a different informant and with a different emotion. The whole session was videotaped.

**Manipulation check**

To ensure the fit of the emotions that should be displayed by the experimenter and parent and the emotions that actually were displayed in the study, a research assistant (blind to the provisions of
emotions) assigned the informants’ emotions to one of three categories (i.e., positive, negative, or neutral) using the recorded videos. For all trials, the displayed emotions matched the category they belonged to (all $r_s \geq .930$, all $p < .001$). In 11 of 685 trials, the emotions expressed by the parents could not be assigned to one of the given categories; therefore, these trials were excluded from the analyses. The reliability of the evaluation of the informants’ emotions was coded from another naive research assistant for 25% of the participants and resulted in sufficient and high correlations (all $r_s \geq .840$, all $p < .001$).

Coding and analyses

Looking behavior

To measure an infants’ looking to the box and to the informants, we used a media player to code their looking behavior from the recordings of the first camera for these two variables: looking time...

Fig. 2. An overview of the procedure of the study. The figure shows the presentation phases (left photos) and infants’ subsequent exploratory behavior (i.e., action phase; right photos) when the box was presented in the neutral trial (A), when the parent presented the box (B), and when the experimenter presented the box (C). The presentation phases (B and C) were conducted in two trials each: one trial with positive emotions and another trial with negative emotions displayed by the presenting informant.
and gaze switches. Looking time (in seconds) was coded whenever an infant looked at one of the following three areas: the parent’s face, the experimenter’s face, or the box. We then calculated the percentages of looking time for each of the three areas separately. Gaze switches consisted of the number of gaze shifts the infant performed between the box and each of the two informants. Thus, we measured both the number of gaze switches between the experimenter and the box and the number of gaze switches between the parent and the box. Both the looking time and the gaze switches were coded during the presentation phase (mean presentation time was 30.3 s, with no systematic difference between the experimenter and the parent, \( t(101) = 0.977, p = .331, d = 0.10 \)). Moreover, we coded the looking time at the experimenter and the gaze switches between the experimenter and the box only in those trials where the experimenter presented the box (because only in those trials did the experimenter provide information), and we coded the looking time at the parent and the gaze switches between the parent and the box only in those trials where the parent was the informant. We also analyzed the looking time and the gaze switches in the neutral trial where both informants were available but not providing information in order to get a baseline of the infant’s looking behavior.

**Exploratory behavior**

Three measures of infants’ exploratory behavior were coded within the 60-s action phase in order to receive a detailed picture of how extensively infants explored the box. We coded (a) the number of seconds infants touched the frame of the exploration box, (b) the number of seconds infants touched the box’s singular functions or elements, and (c) the number of seconds infants spent looking at the box. Note that this latter measure of infants’ looking time at the box (c) was coded when infants could already act on the box during the action phase and, thus, is different from the one we coded for infants’ looking behavior during the presentation phase. We then calculated the exploration time score as a mean of these three exploration measures. Depending on trial type, we measured exploration time when the experimenter, the parent, or both put the box on the table. To guarantee that all trials were of similar presentation quality, we excluded those trials in which the parent or experimenter made one major mistake or at least three minor mistakes. Major mistakes were counted as cases in which the positive and negative emotions were not distinct (\( n = 11 \)). Minor mistakes were counted as cases in which there were minimal deviations in the wording during the presentation phase (\( n = 12 \)). To assess inter-rater reliability, a naive research assistant, who was blind to the aims and hypotheses of the study, coded 25% of the sample. The intraclass correlation coefficient (ICC) for the inter-rater reliability was \( .983, p < .001 \) for the looking time at the experimenter, \( .973, p < .001 \) for the looking time at the parent, and \( .977, p < .001 \) for the looking time at the box. The ICC for the inter-rater reliability was \( .855, p < .001 \) for the gaze switches between the experimenter and the box and was \( .926, p < .001 \) for the gaze switches between the parent and the box. The ICC was \( .985, p < .001 \) for the exploration time when the experimenter presented the box, \( .971, p < .001 \) for the exploration time when the parent presented it, and \( .963, p < .001 \) for the exploration time in the neutral trial. We checked for normal distribution and variance homogeneity. To control for multiple testing, we corrected the \( \alpha \) level of the \( t \) tests by distributing the 5% \( \alpha \) level by the number of \( t \) tests we conducted for each variable.

**Results**

**Control analyses**

Because previous research suggests that boys are more active than girls when it comes to toy exploration (Goldberg & Lewis, 1969), we also checked for possible gender differences. We did not find gender differences for the time infants spent exploring the boxes, \( F(1, 81) = 2.014, p = .160 \), the time infants spent looking at the box, \( F(1, 97) = 1.653, p = .202 \), or the gazes infants switched between the informants and the box, \( F(1, 113) = 2.401, p = .124 \). However, infants’ gender had an effect on the looking time at the informants, \( F(1, 97) = 5.828, p = .018 \), revealing that girls (\( M = 44.9\% \) of looking time) looked longer at the informants than did boys (\( M = 38.9\% \) of looking time), \( t(100) = -2.286, n_{girls} = 48, n_{boys} = 54, p = .024, d = 0.45 \). Because the experimenter was a male adult for all participants, we further analyzed whether there were differences for infants tested with their mothers.
(different-gendered informants) and infants tested with their fathers (same-gendered informants). Given the corrected α level, there were no differences for any of the measures [looking time at the informants: F(1, 88) = 0.812, p = .370; looking time at the box: F(1, 88) = 0.947, p = .333; gaze switches between the informants and the box: F(1, 102) = 2.885, p = .092; exploration time: F(1, 73) = 0.626, p = .432]. Furthermore, neither the order of the displayed emotions (i.e., positive emotions first vs. negative emotions first) nor the order of the presenting informants (i.e., experimenter first vs. parent first) resulted in effects on the dependent variables (all ps ≥ .183 and ≥ .166, all Fs ≤ 1.586 and ≤ 1.824, respectively). Moreover, as we analyzed for the neutral trial, infants’ explorative behavior did not differ among the five boxes (all ps ≥ .345), indicating that infants had no preference for a certain box per se. Finally, to investigate whether infants’ increased looking at the experimenter during the presentation phase (see below) was caused by a motivation to learn about the experimenter instead of learning about the object, we investigated habituation effects. That is, because the experimenter remained the same during the experiment and the objects changed, in the case of learning about the experimenter one would expect a decrease in looking time at him (habituation effect). The same proportion of infants saw the experimenter present the object in the first trial (58 of 137) as in the last trial (58 of 137). The looking time at the experimenter in the first trial (mean = 22.9% of presentation time) did not differ from that in the last trial (mean = 21.8% of presentation time), t(136) = 0.373, p = .710, d = 0.03. In a second analysis, we compared infants’ looking time at the experimenter in the first trial he presented the object versus that in the second trial he presented the object (irrespective of trial number and emotion displayed). Whereas in the previous analysis we compared trials in which infants received different conditions (experimenter presented, parent presented, or neutral trial), this analysis focused on trials in which the experimenter presented the object. Results were the same; infants looked at the experimenter equally long when the he presented for the first time (mean = 42.9% of presentation time) compared with when he presented for the second time (mean = 42.5% of presentation time), t(136) = 0.246, p = .806, d = 0.02.

Looking behavior

To examine infants’ preference for one of the two informants when the informants provided information about the exploration box, we analyzed infants’ looking time at both informants, their looking time at the box when the experimenter or the parent presented it, and their gaze switches between the experimenter and the box and between the parent and the box. Repeated-measures analyses of variance (ANOVAs) were conducted to examine possible interaction effects among the two informants, their emotional information, and the two contexts (lab and home context). Note that in the following subsections, descriptive data are provided only in cases where the number of participants who were included in the inferential statistics is different from the number of participants who have data in at least one of the two variables that were statistically compared (e.g., in the case of paired comparisons). For all the other descriptive statistics, see Tables 1 and 2.

Table 1
Mean percentages (and standard deviations) of looking time at the informants and at the exploration box, mean number of gaze switches between the informants and the box, and mean percentages of exploration time when the experimenter and the parent presented the box in the laboratory, the infant's home, and across contexts.

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<tr>
<th></th>
<th>Laboratory</th>
<th>Home</th>
<th>Across contexts</th>
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<tbody>
<tr>
<td></td>
<td>Exp</td>
<td>Par</td>
<td>Exp</td>
</tr>
<tr>
<td>Looking time at informants</td>
<td>49.3 (16.2)</td>
<td>31.8 (15.2)</td>
<td>42.0 (17.4)</td>
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<td>Looking time at box</td>
<td>29.8 (9.6)</td>
<td>41.9 (14.5)</td>
<td>39.3 (12.9)</td>
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<td>4.9 (2.7)</td>
<td>5.5 (2.4)</td>
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<td>Exploration time</td>
<td>68.4 (19.2)</td>
<td>72.8 (12.6)</td>
<td>68.9 (20.0)</td>
</tr>
</tbody>
</table>

Note. Exp, experimenter; Par, parent.
Table 2
Mean percentages (and standard deviations) of looking time at the informants and at the exploration box, mean number of gaze switches between the informants and the box, and mean percentages of exploration time when the experimenter and the parent presented the box in the laboratory, in the infant's home, and across contexts as a function of positive and negative emotions as well as when no informant presented the box in the baseline condition.

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<td>Exp Neg</td>
<td>Par Pos</td>
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</tr>
<tr>
<td>Gaze switches</td>
<td>5.9 (3.0)</td>
<td>5.5 (2.5)</td>
<td>5.1 (3.1)</td>
</tr>
<tr>
<td>Exploration time</td>
<td>67.7 (22.8)</td>
<td>67.5 (24.6)</td>
<td>72.8 (17.5)</td>
</tr>
</tbody>
</table>

Note. Exp, experimenter; Par, parent; Pos, positive; Neg, negative.
Looking time at the informants

First, we investigated whether infants looked more at the experimenter or at the parent when he or she provided information compared with when he or she did not (neutral trial) in order to check whether participants indeed paid attention to our manipulation of presenting an object. Infants looked at the experimenter more when he presented the box \( M = 45.3\% \) of presentation time, \( SD = 17.1 \) than when he did not during the neutral trial \( M = 16.1\% \) of presentation time, \( SD = 11.9 \), \( t(120) = 17.919, p < .001, d = 1.98 \). Infants also looked longer at the parent when the she or he presented the box \( M = 29.9\% \) of presentation time, \( SD = 14.9 \) than when she or he did not during the neutral trial \( M = 10.7\% \) of presentation time, \( SD = 9.2 \), \( t(100) = 12.119, p < .001, d = 1.55 \). Furthermore, we analyzed infants’ looking time at the experimenter versus the parent in the neutral trial. There, infants looked significantly longer at the experimenter \( M = 16.3\% \) of presentation time, \( SD = 12.1 \) than at the parent \( M = 10.5\% \) of presentation time, \( SD = 8.9 \), \( t(124) = 4.284, p < .001, d = 0.54 \).

A repeated-measures ANOVA with informants (the experimenter vs. the parent) and emotion (positive vs. negative) as within-participants factors and context (laboratory vs. infants’ home) as a between-participants factor did not reveal an interaction of informant and context, \( F(1, 99) = 0.430, p = .513 \). Moreover, there was neither a main effect of emotion, \( F(1, 99) = 0.737, p = .393 \), nor a main effect of context, \( F(1, 99) = 2.957, p = .089 \). However, there was a main effect for informant, \( F(1, 99) = 84.363, p < .001, \eta^2 = .460 \), indicating that infants looked significantly longer at the experimenter than at the parent, across emotions and contexts. There were no other significant main effects or interactions \( (p > .05) \).

Looking time at the exploration boxes

A repeated-measures ANOVA with informant (experimenter vs. parent) and emotion (positive vs. negative) as within-participants factors and context (laboratory vs. infants’ home) as a between-participants factor did not reveal an interaction of informant and context, \( F(1, 99) = 0.555, p = .458 \).

However, there was a main effect of emotion, \( F(1, 99) = 6.824, p = .010, \eta^2 = .064 \), indicating that infants looked longer at the boxes when they were presented with positive emotions \( M = 40.7\% \) of presentation time, \( SD = 13.1 \) than when they were presented with negative emotions \( M = 37.8\% \) of presentation time, \( SD = 13.6 \). There was also a main effect of context, \( F(1, 99) = 10.311, p = .002, \eta^2 = .094 \), indicating that infants looked longer at the boxes in their home \( M = 39.5\% \) of presentation time, \( SD = 11.9 \) than in the laboratory \( M = 30.1\% \) of presentation time, \( SD = 10.2 \). Furthermore, there was a main effect of informant, \( F(1, 99) = 47.033, p < .001, \eta^2 = .322 \), indicating that infants looked longer at the box when the parent presented it than when the experimenter presented it. There were no other significant main effects or interactions \( (p > .05) \). For mean percentage times, see Table 1.

Gaze switches

First, we investigated whether infants switched gaze more between the experimenter and the box or between the parent and the box when he or she provided information compared with when he or she did not (neutral trial) in order to examine whether participants indeed paid attention to our manipulation of presenting an object. Infants switched gaze more between the experimenter and the box when the experimenter presented the box \( M = 5.6 \) gaze switches, \( SD = 2.3 \) than in the neutral trial \( M = 2.0 \) gaze switches, \( SD = 2.0 \), \( t(120) = 14.400, p < .001, d = 1.67 \), and also switched more between the parent and the box when the parent presented it \( M = 4.9 \) gaze switches, \( SD = 2.8 \) compared with the neutral trial \( M = 1.4 \) gaze switches, \( SD = 1.5 \), \( t(116) = 13.743, p < .001, d = 1.56 \).

A repeated-measures ANOVA with informant (experimenter vs. parent) and emotion (positive vs. negative) as within-participants factors and context (laboratory vs. infants’ home) as a between-participants factor did not reveal an interaction of informant and context, \( F(1, 115) = 0.013, p = .909 \). Moreover, there was neither a main effect of emotion, \( F(1, 115) = 2.851, p = .094 \), nor a main effect of context, \( F(1, 115) = 0.062, p = .803 \). However, there was a main effect of informant, \( F(1, 115) = 8.018, p = .005, \eta^2 = .065 \). Consistent with infants’ looking time measures above, infants more frequently alternated their gaze between the experimenter and the boxes compared with the number of gaze switches between the parent and the boxes. There were no other significant main effects or interactions \( (p > .05) \).
Exploratory behavior

To measure how the emotional information of the experimenter and the parent influenced infants’ exploratory behavior toward the boxes, we analyzed infants’ box exploration during the 60-s action phase that followed the informants’ presentations of the boxes. Repeated-measures ANOVAs were conducted to examine possible interaction effects among the two informants, their emotional information, and the two contexts of the experiment.

An omnibus repeated-measures ANOVA with informant (experimenter vs. parent) and emotion (positive vs. negative) as within-participants factors and context (laboratory vs. infants’ home) as a between-participants factor did not reveal an interaction effect of informant and context, $F(1, 83) = 0.588, p = .445$. Moreover, there was neither a main effect of emotion, $F(1, 83) = 0.001, p = .973$, nor a main effect of context, $F(1, 83) = 1.419, p = .237$. However, there was a main effect of informant, $F(1, 83) = 9.283, p = .003, \eta^2 = 101$. Infants explored more when the parent presented the box than when the experimenter presented the box.

We also analyzed how long it took infants to explore the box to check for differences between trials in which the experimenter or the parent presented the object. Infants’ delay before exploring the box was larger when the experimenter presented the box ($M = 2.3$ s, $SD = 6.3$) than when the parent presented it ($M = 1.0$ s, $SD = 3.5$), $t(127) = 2.086, p = .039, d = 0.18$. This difference also occurred in terms of the number of infants. When the parent presented the box, 83.3% of infants immediately explored the box. When the experimenter presented the box, 67.7% of infants did so. A comparison of instances with a delay ($n = 14$) or without a delay ($n = 80$) when the experimenter and the parent presented the box resulted in a significant difference, McNemar test, $N = 129, p = .002$. Accordingly, significantly more infants showed a delay when the experimenter presented the box but not when the parent did ($n = 27$) than infants who showed a delay when the parent presented the box but not when the experimenter did ($n = 8$).

We further checked whether infants’ exploratory behavior in the four presenter conditions differed from baseline levels during the neutral trial (baseline: $M = 69.9\%$ of action time, $SD = 22.6$). Infants explored the box no differently than baseline levels when the experimenter presented the box with positive emotions, $t(109) = 0.054, p = .957, d = 0.01$, or negative emotions, $t(110) = −0.323, p = .747, d = −0.03$ (for descriptive statistics, see Table 2). Moreover, given the corrected $\alpha$ level, infants explored the box no differently than baseline when the parent presented the box with positive emotions, $t(101) = 2.089, p = .039, d = 0.21$. However, infants did explore the box more than baseline when the parent presented the box with negative emotions, $t(97) = 2.571, p = .012, d = 0.27$. There were no other significant main effects or interactions ($p > .05$). For descriptive statistics, see Table 2.

Discussion

The primary aim of the current study was to get a clearer picture of infants’ social referencing behavior across the contexts of home and the laboratory and with both familiar and unfamiliar informants present. We found a main effect of informant on infants’ looking behavior in that infants generally looked longer at the unfamiliar experimenter than at their more familiar parent across both contexts. Interestingly, this looking-based pattern did not hold for infants’ exploratory behavior. There, participants explored the boxes more when the parent presented them compared with when the experimenter presented them. We did not find evidence for a person–context association, neither in infants’ looking behavior as an indicator for information search nor in infants’ exploratory behavior as an indicator for information use. Rather, whereas we found no effect of context on infants’ social referencing, we found distinct effects of informant familiarity on infants’ information search and use.

When the informants provided information, infants looked longer at the experimenter than at their parent and switched gaze more between the experimenter and the box than between their parent and the box regardless of the context and emotional valence. Thus, even in the home context, infants looked longer at the experimenter than at their parent when searching for information about the novel box. This looking preference confirms what has been found in only laboratory settings (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005) and extends these findings to infants’ home settings. Thus, the current findings demonstrate that infants’ heightened social referencing toward the
experimenter is a robust phenomenon found in familiar home contexts as well as in the laboratory. Moreover, infants alternated their gaze between the experimenter and the box when he provided information more than in the baseline condition. This indicates that infants not only looked longer at the experimenter in general but also related the information provided by the experimenter as referring to the box (see Repacholi, 1998, for 14-month-olds’ success in relating emotional expressions to the content of containers). Another finding supporting this interpretation is that infants’ looking time at the experimenter did not decrease during the experiment; infants looked equally long in the first trial the experimenter presented the object and in the second trial he presented the object, with no habituation taking place. More generally, these results emphasize that social referencing among 14-month-olds is not solely motivated by looking at their parents for their own comfort and safety (see also Stenberg & Hagekull, 1997).

One might wonder how to explain infants’ preference for the experimenter in their looking behavior across contexts best. There are at least two possible interpretations of this effect. First, it may be that infants considered the experimenter to be the better source of information about the boxes. After all, the boxes themselves were novel and, therefore, may have been associated more with the experimenter, who was also novel in both contexts, than with the parent. Infants’ longer looking was not characterized simply by prolonged fixations to the experimenter himself but also by alternating their gaze between him and the box he presented. Given evidence that infants are capable of representing simple ownership relations (Blake & Harris, 2009; Blake & Harris, 2011; Fasig, 2000; Hay, 2006), it could be that the boxes’ novelty across contexts supported infants’ interest in acquiring information from the novel experimenter who seemed familiar with the boxes. If this interpretation is correct, then the current findings are consistent with a reformulated version of Stenberg’s (2009) person–context association. That is, infants’ selective appeal to experimenters might be explained not by inferences about how certain individuals relate to a certain environmental context but rather by inferences about how individuals relate to the novel objects these individuals present, handle, and discuss (i.e., object–expertise hypothesis).

Second, infants’ increased looking at the experimenter during the presentation phase might have been caused simply by the fact that the experimenter was novel to participants. This novelty alone may have elicited more attention to the experimenter because novelty does attract infants’ attention (Fantz, 1964; Rose & Tamis-LeMonda, 1999). A finding from the current study might support this novelty explanation: During the neutral trial, when no informant provided any information about the novel box, infants still looked longer at the experimenter than at the parent. However, infants’ preferential attention to the experimenter might reflect the expectation that he will provide information about the box on the neutral trial. The current finding that infants’ looking time at the experimenter did not decrease during the duration of the experiment also argues against the idea that infants’ predominant looking at the experimenter was caused solely by novelty alone. The results of other studies also argue against the mere novelty explanation; for example, 12-month-olds looked more at a less novel experimenter than at a completely novel experimenter in a social referencing paradigm (Stenberg, 2012), and 9- to 24-month-olds looked longer at pictures of their parents than at pictures of unfamiliar persons (Brooks-Gunn & Lewis, 1981). Nevertheless, future studies need to clarify in more detail the underlying motivations of infants’ looking preference in social referencing paradigms including parents as familiar informants and novel experimenters as unfamiliar informants.

Another interesting pattern of results is reflected by infants’ looking behavior at the exploration box when presented by the informants. There, infants looked longer at the box when presented by their parent than when presented by the experimenter; moreover, they looked longer at the box in their home compared with the laboratory context. This suggests that the more familiar the informant and context were, the better infants were able to focus on the object about which information was provided in the social referencing situation. On the other hand, an unfamiliar informant or context might distract infants’ attention from the relevant object, possibly because infants need to find out how to evaluate the unfamiliar informant and context and are occupied with processing this information. Consequently, one might assume that infants learn best when the learning environment—that is, everything except the action or object to be learned—is familiar. Therefore, even previous findings that reported a familiarity preference could be explained in this way (Walden & Kim, 2005).
In the current study, the effect of the informants on infants’ exploratory behavior was in the opposite direction to that found for infants’ looking at the informants. Infants explored the boxes more when their parent presented them than when the experimenter presented them regardless of the accompanying emotions and the context of home or laboratory. The same result arose when analyzing infants’ exploratory behavior when the informants presented the box compared with the neutral trial. Whereas infants explored the boxes more than baseline when the parent presented them (at least when accompanied by negative emotions), they explored them at baseline level when the experimenter presented them. Thus, infants’ looking preference for the experimenter was not mirrored in their exploration of the boxes and, therefore, does not necessarily determine their explorative behavior. This finding suggests that infants’ looking to the informant during the presentation phase is independent of their subsequent explorative behavior.

Infants’ explorative behavior may reflect 14-month-olds’ more general trust in a familiar caregiver, resulting in a more efficient or rapid referencing of the parent due to the cumulative experience with this person (i.e., “familiarity effect”; Corriveau et al., 2009; Walden & Kim, 2005, p. 360). This interpretation is supported by our finding that infants looked at the novel box more when presented by the parent than when presented by the experimenter. The familiarity of the informant, therefore, might support infants’ visual and tactile exploration of novel objects. In line with this finding, Corriveau and Harris (2009) found that 3-year-olds (as well as 4- and 5-year-olds) searched for and used information more when provided by a familiar teacher rather than by an unfamiliar teacher. When the authors contrasted familiarity with inaccuracy, only the youngest children (3-year-olds) still trusted the more familiar informant despite her past inaccuracy. Thus, a readiness to use information provided by trusted familiar informants may be present during infancy and continue into early childhood (Corriveau et al., 2009).

The finding that familiar informants support infants’ exploration of novel objects is further supported by individual differences in infants’ exploratory behavior: the standard deviation when the unfamiliar informant presented the box was nearly twice as large as when the familiar informant presented the box. Some infants had much lower exploration scores than others and waited longer before exploring the box when it was presented by an unfamiliar informant compared with a familiar one. One explanation for the bigger inter-individual differences in waiting time with the unfamiliar informant is that whereas all infants trusted the familiar informant to a similar level (given the amount of experience they had with their parent) and started to explore the object presented by this informant without a significant delay, differences in infants’ level of readiness to trust an unfamiliar person made them delay their exploration to different degrees. Thus, future research might explore the sources of these individual differences on infants’ exploratory behavior more deeply.

In the current project, infants did not use the information provided by the experimenter in the laboratory context, in contrast to findings of Stenberg (2012, 2013). One might argue that this is due mainly to a lack of an association between the experimenter and the laboratory context. It is true that, compared with the extensive experience infants have with their parent in their home, participants did not have as much experience with the experimenter in the laboratory (and, actually, they experienced their parent in this context as much as they experienced the experimenter in this context). However, we modeled our demonstration of the experimenter’s expertise in the laboratory closely after the successful manipulation in a previous study that investigated the person–context association (Stenberg, 2009). Thus, we made sure that the experimenter expressed his expertise in the laboratory by showing the parents how to get to the laboratory (he opened the doors, he showed the family where to sit, he offered and provided the beverages, etc.). All these indicators of competence were reversed at the infants’ home and observable for participants in both contexts; that is, when visiting the home, it was the parents who opened the doors, showed the experimenters where to sit, offered the experimenters beverages, and so on. Second, it is important to note that despite infants’ extensive experience with their parent in the context of their home, they did not show a uniform referencing pattern in the direction of their parent. Rather, infants looked longer at the unfamiliar experimenter in their home context despite this extensive experience. As a result, our findings call for continued care in how social referencing is measured.

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1 We are grateful to two anonymous reviewers for pointing this out to us.
(Aslin, 2007), across a range of contexts (lab, home, and school), so that we can make more specific claims regarding how distinct aspects of social referencing are influenced by persons and contexts (Baldwin & Moses, 1996; Shneidman & Woodward, 2016).

Although we found effects of the informants’ familiarity on infants’ exploratory behavior, there was no such effect of the emotions that accompanied the informants’ presentation on infants’ exploratory behavior in the current study. Consequently, one might wonder whether infants recognized the differences between the displayed emotions (positive or negative) at all and whether they understood their valence and directedness. One piece of evidence that infants considered the displayed emotions as different in terms of their valence can be concluded from the manipulation check (see Results). Moreover, infants showed differences in gaze behavior depending on the informants’ emotions; they looked longer at the box when the informants displayed positive emotions than when they displayed negative emotions (independent of who presented them). Thus, infants did recognize differences between the displayed emotions, and even possibly their directedness and their valence, as did 14-month-olds in previous studies (de Rosnay et al., 2006; Klinnert, 1984; Moses et al., 2001; Mumme & Fernald, 2003; Repacholi, 1998; Sorce et al., 1985). However, differences in emotional valence were not registered in infants’ own action planning and execution. One reason for this could be that they assessed the informants’ evaluations of the box as subjective attitudes that did not affect their own evaluation of the box (see Zmyj et al., 2010, for a similar argumentation for 14-month-olds’ lack of selectivity in an object–choice task). Another reason might be that the negative emotions shown in the current study (e.g., dislike and disgust) were not sufficiently salient or meaningful enough to infants as would have been other more alerting emotions such as anger and sadness (Nelson, 1987; Repacholi, 2009). Aside from these possibilities, we chose against using more alerting emotions mainly because we did not want to risk presenting any threatening attitudes to our participants. We also modeled our emotional displays after those found to be effective with younger age groups in the literature (Stenberg, 2013; Walden and Kim, 2005).

In conclusion, our study contributes important new empirical evidence to our understanding of infants’ selective information search and information use in social learning situations. The current findings suggest that infants aged 14 months are selective in their search and use of social information. When provided with information about a novel object, they prefer to look to an unfamiliar informant over a familiar informant, and at the same time, look at the novel object longest when presented by the familiar informant in the home context. When it comes to the use of information—that is, the active manipulation of a novel object—infants explore the object more when presented by their parent. These results underline the distinct role played by familiarity in infants’ referencing and social learning across contexts. The dissociation between the factors that influence information search and use seems to be robust across certain emotions and contexts. Infants’ familiarity with informants supports their exploration at 14 months of age and calls for future work to examine individual and developmental differences in infants’ use of familiarity as a guide for social learning.

References


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