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Mapping language to the mind: Toddlers' online processing of language as a reflection of speaker's knowledge and ignorance

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The current research examined whether young children react to inconsistencies between a speakers' language and her knowledge or lack of knowledge about reality. Gaze behavior at the speaker was examined during two key frames: prior and post location name. Present findings demonstrate that even before the location name is spoken, the 24-month-olds (N = 122) differentiate between the scenarios in which the speaker is knowledgeable or ignorant about where the object is. Following the location name, infant gaze was largely influenced by the inconsistency of the language. That is, infants looked more at the speaker when she mentioned a location name that was inconsistent with her knowledge or lack of knowledge of the object's transfer. The current results demonstrate that by two years children have begun to take into account other speakers' knowledge or ignorance of an event as they process statements about reality.

1. Introduction

Successful communication depends, among other things, on the ability to evaluate our communicative partner's intentions and knowledge. One efficient way to make inferences about others' mental states is to observe their interactions with objects in the environment. Another way to assess other person's mental content is through what the person verbally communicates about a current or past situation. While early in development observing others' behavior is necessary to evaluate what others know, as the child develops, the increasing mastery and reliance on language provides an alternative route to this type of information. Language can be used to communicate one's knowledge about reality and thus it provides a means to assess children's understanding of the relation between verbal statements, knowledge, and reality (Astington & Baird, 2005). The primary goal of the present research is to examine the extent to which children evaluate a linguistic statement as a reflection of a speaker's knowledge about reality.

Research has shown that beginning in infancy children track others' interactions with objects in the environment and use information about what others have experienced to interpret references to present (Ganea & Saylor, 2007; Moll, Koring, Carpenter, & Tomasello, 2006; Moll & Tomasello, 2007) or absent things (Saylor & Ganea, 2007). In instances when the reference is ambiguous (e.g. "Can you give *it* to me?") 14-month-old infants recall the experimenter's previous interaction

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with particular objects to disambiguate the request (Saylor & Ganea, 2007). By 18 months, children are able to make such disambiguation by simply recalling which object an adult attended to visually (Akhtar, Carpenter, & Tomasello, 1996), demonstrating an increasingly robust ability to monitor another person's attention source.

Young children can also judge when others are ignorant about certain objects or events. Starting at around 12 months, children point to inform adults about missed events (Liszkowski, Carpenter, Striano, & Tomasello, 2006; Liszkowski, Albrecht, Carpenter, & Tomasello, 2008) and they begin to seek information from the more knowledgeable (Stenberg, 2012) and reliable social partners (Chow, Poulin-Dubois, & Lewis, 2008). By the time they are 2 years old, they are able to adjust the content of their own communicative attempts based on whether their communicative partner is knowledgeable or ignorant about an event. For instance, in a study by O'Neill (1996), 24-month-olds observed an experimenter hide an object in one of two locations that were out-of-reach for the child. The child's communicative partner, his mother, was either present or absent during the hiding event. Later on, toddlers gestured significantly more for their mothers to get the object when the mother was previously absent, and therefore was ignorant about where the desirable object was, than when she witnessed the hiding and was therefore knowledgeable about the object's location.

To summarize, by their second birthday children interpret others' communicative behavior based on whether or not the person was present during a particular event, attended to it, or interacted with specific objects in the environment. An outstanding question however concerns the extent to which young children understand that others' verbal or physical contact with objects leads to knowing. In other words, do infants attribute causal connections between the objects a person is observing and her knowledge of them, or do they simply associate a person with certain objects because both co-occur together and adjust their communicative attempts accordingly based on a simpler rule? O'Neill (1996) offers such an explanation for 2-year-olds' performance in her studies, by arguing that children may simply want to update the parent about relevant things that happened while the parent was absent. This disengagement + updating explanation would be based on a simple rule of the form "Tell people about significant happenings they did not take part in with me." (O'Neill, 1996; p. 674).

One way to address this question is to test children's reaction during events where the link between a person and an object is no longer a valid cue for accurate inferences about behavior. The unexpected transfer false belief task (Wimmer & Perner, 1983) is one such task, presenting the child with an event in which an actor's behavior is inconsistent with her knowledge of reality. Recent investigations have indicated that infants are sensitive to events in which an actor's behavior violates what she should know (Onishi & Baillargeon 2005; Surian, Caldi, & Sperber, 2007). For example, 15-month-olds look longer when an agent searches, by reaching into one of two locations, for an object where it actually is, rather than where she knows it to be. In other words, they show heightened interest when an agent who has not witnessed the hiding event nevertheless accurately searches for the object (Onishi & Baillargeon, 2005).

One factor that is likely to aid infants with many of the existing tasks measuring child's violation of expectations (VoE) about reality is the presence of behavioral cues that highlight inconsistencies between behavior and knowledge during test events. In a standard, infant-directed false belief task, for instance, children are typically presented with an agent displaying explicit bodily movements that highlight the agent's search for an object in a location she doesn't know the object to be. In some cases the agent attempts to unsuccessfully open one of the two boxes (Buttelmann, Carpenter, & Tomasello, 2009), or reaches into the box in an attempt to retrieve the object (Luo, 2011; Onishi & Baillargeon, 2005; Song, Onishi, Baillargeon, & Fisher, 2008), points to (Southgate, Chevallier, & Csibra, 2010) or moves toward (Surian et al., 2007) one of the locations. Each of these behaviors (reaching, pointing, searching) provides observable and salient evidence that indicates an agent's intent to retrieve an object, highlighting the mismatch between the agent's current behavior and the agent's knowledge about the object's location.

Consistent with the possibility that behavioral cues aid infants in passing many of the existing VoE tasks, studies that have measured anticipatory (looking *prior* to an agent's search event) rather than reactive looking (looking *following* an agent's search) report positive performance later, at around 2 years of age. In a study by Southgate, Senju and Csibra (2007), 25-month-olds, but not younger infants, were able to accurately anticipate an actor's search behavior prior to observing it, suggesting that they understood that the actor would subsequently behave in a manner consistent with her knowledge of reality.

When anticipatory looking was measured following an explicit linguistic cue, positive findings were evident even later. He, Bolz and Baillargeon (2012) found that children at 30-months anticipate an agent to look for the object in the location she believes it to be, following a self-addressed utterance (*"Where will she think they [the scissors] are?"*). In another study, when the verbal utterance was a direct verbal prompt (*"I wonder where she's going to look"*), 37-month-olds, but not younger children, looked toward the location where the agent last left the object, revealing their ability to recognize what the person knows and appropriately predict her behavior according to what she knows (Garnham & Ruffman, 2001).

In sum, when behavioral cues have been removed (such as in the anticipation paradigm) or when less salient cues were used (such as language) successful performance on tasks measuring knowledge or ignorance was delayed with positive findings reported with infants at around 2 years. Another way to assess children's understanding of knowledge states is to examine their reaction to situations in which language does not reflect a person's knowledge about reality. By doing so, we can isolate children's reasoning about others' knowledge from simple associations between people and objects, because when a speaker makes a statement about reality no visible link between the person and the objects in the environment is established.

The present study supplements a small body of research examining young children's reactions to language as a reflection of one's knowledge about reality. In one study using the false labeling paradigm (Koenig & Echols, 2003), 16-month-olds were presented with series of photographs depicting commonly known objects (a ball, a cat, a shoe, a chair etc.) that were either accurately or inaccurately labeled by a human speaker. Results show that infants looked longer at the human speaker when she falsely mislabeled visible familiar objects, but looked longer at the objects themselves when the speaker labeled them correctly (Koenig & Echols, 2003). Other studies have shown that by18 months, infants begin to also explicitly reject false labels through verbal protests (Pea, 1982). These studies show that in conditions in which the speaker's knowledge is not experimentally manipulated, infants expect others to use conventional labels to name familiar objects. As these studies suggest, children as young as 18 months are sensitive to language inconsistencies in false labeling of known and visible objects. Nevertheless, studies assessing whether infants keep track of objects and others' knowledge of them (e.g., false belief tasks) suggest that when language is used as a reflection of a person's knowledge of an event children older than 2 years of age may be able to detect such violations but not younger ones. Given this evidence we focus the present study on children who are 2 years of age.

Children's reactions to inconsistencies between a person's language and reality have been examined in contexts where the child's own knowledge and that of the speaker are presumably shared (such as when both are looking at familiar objects). In the present study we examined children's reactions to language violations in contexts in which the child's knowledge of reality is different than that of the speaker. In particular, we asked whether 24-month-olds respond to violations between a person's knowledge about an object's location and her statement about that object's location. Based on prior research (Baron-Cohen, 1997; Koenig & Echols, 2003), we examined the amount of time infants spent scanning the speaker's face based on whether the speaker was knowledgeable or ignorant about object's location, and whether her language was consistent with her knowledge or not.

In instance when the speaker was ignorant, the speaker's statement was either consistent (Ignorant Consistent) or inconsistent (Ignorant Inconsistent) with the speaker's lack of knowledge. Looking times at these events were further compared to looking when the speaker was knowledgeable of the object's location, but her statement was again either consistent (Knowledgeable Consistent) or not (Knowledgeable Inconsistent) with it. If infants expect others' language to reflect their knowledge, within both the Ignorant and the Knowledgeable conditions, infants should look longer when the speaker is making a statement that is inconsistent with her knowledge or lack thereof (Knowledgeable Inconsistent, Ignorant Inconsistent > Knowledgeable Consistent, Ignorant Consistent). Finally, within these conditions, we predicted that children would look longer at the speaker when her statement inaccurately reflects her knowledge rather than when her statement correctly reflects her ignorance. That is, in cases in which she is knowledgeable, we predict longer looking when her statement is inconsistent with her knowledge than when it is (Knowledgeable Inconsistent > Knowledgeable Consistent). In cases in which the speaker is ignorant, we predict infants to look longer at the speaker when she correctly states object's location, thus inaccurately reflects her ignorance, than when her statement is consistent with her ignorance (Ignorant Inconsistent > Ignorant Consistent).

Infants' visual attention to the speaker was analyzed as the language unfolded – before and after the location name was spoken. This was done in order to provide evidence about on-line processing of language as a reflection of another person's knowledge state.

2. Methods

2.1. Participants

One hundred and twenty-two 24-month-olds (M = 23.9 mo., SD = 0.81; 69 girls) were randomly assigned to one of four conditions. In two of the conditions, the speaker did not see the object's final location, and thus was ignorant about where the object was. The conditions differed by whether the speaker's statement accurately matched her knowledge: Ignorant Consistent statement (N = 30, 14 girls) and Ignorant Inconsistent statement (N = 30, 16 girls). In the other two conditions, the speaker was knowledgeable about the object's new location, but varied whether her statement matched this knowledge: Knowledgeable Consistent statement (N = 32, 18 girls) and the Knowledgeable Inconsistent statement (N = 30, 14 girls). An additional 9 children were not included in the analyses: 3 due to lack of data during critical time intervals (lack of gaze data during the language statement) and 6 for insufficient overall gaze recording by the eye tracker ($\leq$10% of gaze samples).

Participants were recruited from a list of parents who indicated interest in participating in research with their child. All toddlers who participated came from a medium-size city in Sweden, were full term at birth, developing typically, and heard Swedish as their primary language at home. Parents received a gift voucher worth approximately 10 euro for participation.

2.2. Apparatus

Infants' looking times were recorded using a Tobii T120 remote eye-tracker with a reported accuracy of 0.5 visual degrees and freedom of head movement within 30 × 22 × 30 cm. Gaze was recorded at 60 Hz and a standard five-point calibration was used (Gredebäck, Johnson, & von Hofsten, 2009). All infants passed the calibration on all five points. Raw gaze data was extracted from Tobii Studio with one fixation calculated as lasting at least 200 ms.

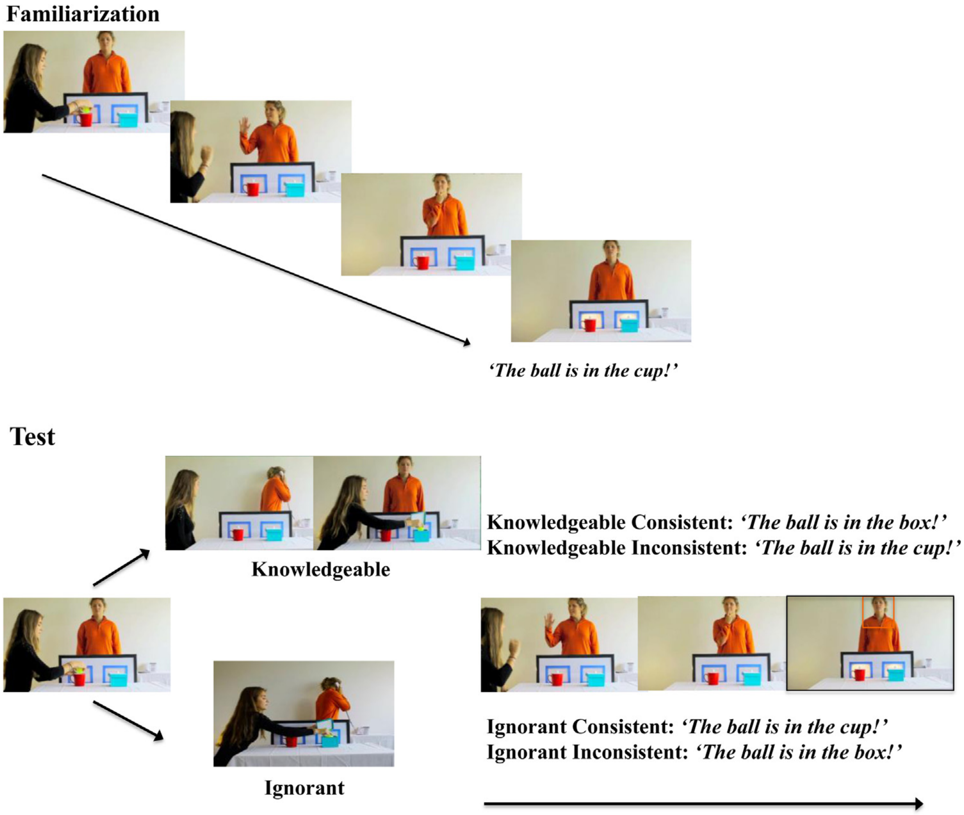

Fig. 1. Stimuli events for the Familiarization and the Test trials indicating the Speaker AOI during the pre- and post location statement.

2.3. Procedure

Toddlers watched a total of 8 video presentations (4 familiarization trials and 4 test trials) of the modified version of the unexpected transfer false belief task. The video presentations featured two human models (the switcher and the speaker) wearing distinct colored t-shirts. The switcher was always sitting on the left-hand side of the table, while the speaker was standing in the center, behind a panel with two windows in front of which were two opaque containers – a blue box and a red cup. Behind the speaker to the right was a white telephone visible to the child (see Fig. 1).

For each child, the video presentation followed the same structure: the label phase, 4 familiarization trials and 4 test trials. During the label phase, each object was pointed to and labeled. During the familiarization trials, the switcher hid the object while the speaker stated where the object was hidden. The last four test trials depicted a modified unexpected transfer false belief task (Wimmer & Perner, 1983) in a between-subject design.

Throughout the study, the physical position of the locations did not change, with the box always being on the right and the cup always on the left. However, in both the familiarization trials and the test trials the initial hiding location was counterbalanced across participants. That is, for familiarization trials half of the children first saw the object hidden in the box (box-cup-box-cup order), while the other half saw it first hidden in the cup (cup-box-cup-box order). The same was true for the test trials: half of the children saw the object first hidden in the box and half in the cup.

2.3.1. Label phase

During the label phase, each of the hiding locations and the object being hidden were placed in the middle of the table by the switcher one at a time, pointed to, and labeled. Only the speaker labeled the locations and the object. The box was labeled first, followed by the cup and then the object, the ball.

2.3.2. Familiarization phase

The purpose of the familiarization trials was to (a) teach the infants that the speaker will state the object's location and (b) show them that the two windows behind the containers illuminated and a chime sounded right before the name of the location is said. The purpose of the chime and light cue was to direct the child's attention to the screen during the location statement.

The familiarization trials began with the switcher, the speaker, the two locations and the object clearly visible to the child. The switcher took the object, hid it in one of the locations, said *"Bye"* to the on-looking speaker and left the scene. After the switcher left the scene, the speaker waited 2 s and looked straight at the camera, tapped her chin as if she tried to remember the object's location and right before the location name was said, the windows behind the locations illuminated and a short chime sounded. All children heard: "*Hmmm. . .the ball is in* (audio-visual cue) ***the cup***" or "*Hmmm. . . the ball is in* (audio-visual cue) ***the box***." There were four familiarization trials and each lasted approximately 19 s.

2.3.3. Test event

Following the familiarization trials, the unexpected transfer test event trials began with the speaker, the switcher and both locations visible to the child. The ball was placed in the middle of the table between the two containers. The event began when the switcher grabbed the toy in a way that did not obstruct it from the child's view and hid it in one of the two locations (for example, the box). After the object was hidden, a phone that was behind the speaker rang, and the speaker turned to the right to pick it up. She proceeded to 'talk' on the phone by making short comments such as "*I see. . .Yes. . .Ok. . .See you!*" for approximately 4 s.

The subsequent actions designated the conditions. In the two knowledgeable conditions, the speaker finished her 'conversation,' hung up the phone, and turned back around. Then, while the speaker was watching, the switcher took the ball out of the hiding location and placed it in the other location. In the ignorant conditions, however, the switcher displaced the object while the speaker was on the phone and turned away from the scene. After the switch was made, the speaker turned back around, the switcher said "Bye" to the speaker and left the scene. After she left, the speaker stated the location of the object as she had during the familiarization trials while looking straight ahead.

The location name further designated the condition, as it was either consistent or inconsistent with the speaker's knowledge. Based on the location, four conditions emerged: Knowledgeable Consistent, Knowledgeable Inconsistent, Ignorant Consistent, and Ignorant Inconsistent. The test trials lasted 34.5 s for the Knowledgeable Consistent condition, 45 s for the Knowledgeable Inconsistent condition, 32.5 s for the Ignorant Inconsistent condition and 27.5 s for the Ignorant Consistent condition.

2.4. Data reduction

Data was analyzed using TimeStudio (www.timestudioproject.com), a Matlab© program specifically designed for analyzing time series data. Percentage of looking times during the test trial were analyzed from a specified area of interest created by hand. Two areas of interest were considered: the Screen AOI and the Speaker AOI. The Screen AOI was a rectangular shape (horizontal size: 31.4 visual degrees, vertical size: 25.4 visual degrees) that encompassed the entire scene. The purpose of the Screen AOI was to determine total looking at the scene and to ensure that the trials included in the analysis were those to which participants sufficiently attended. Any trials in which total looking at the Screen AOI was less than 25% were excluded from further analysis. The Speaker AOI (horizontal size: 6.3 visual degrees, vertical size: 6.7 visual degrees) was a square shape around the actor's face.

Data analysis for the test trial focused on total dwell durations within the Speaker AOI during the statement interval. We focused the dependent variable within the Speaker AOI because of the nature of the current question. In order to draw any conclusions as to whether children's gaze behavior was influenced solely by the nature of the language, we focused on looking at the source of potential discrepancy, the speaker. Mainly, we examined gaze during the statement interval focusing on the time frame before (the pre-location interval) and after the location name was spoken (the post-location interval). The pre-location interval consisted of the initial part of the Statement interval until the start of the audiovisual cue. The post-location interval was the second half of the Statement interval, consisting of the percentage of looking during the location name ('the box' or 'the cup'), from the end of the audiovisual cue until the end of the trial. The length of the pre-location interval ranged from 200 to 400 ms and the post-location interval from 300 to 400 ms. Please refer to Supplementary information for more details.

By considering gaze within these intervals we examine infant visual attention (1) as the language unfolds in anticipation of the location name and (2) as a consequence to the heard location name.

3. Results

Preliminary analyses indicated no significant differences between hiding order, location order (location into which the object was initially hidden) or gender and these groups were collapsed for subsequent analyses.

For each participant, the accumulated looking time in the Speaker AOI as a proportion of looking at the entire screen over the whole trial length was averaged across trials. Looking time was examined during two key time frames: pre-location name interval and post-location name interval.

3.1. Pre-location and post-location interval

In order to examine infant visual attention as the language statement unfolded, we performed a 2 (interval: pre-location name, post-location name) × 2 (knowledge state: knowledge, ignorance) × 2 (language consistency: consistent, inconsistent)

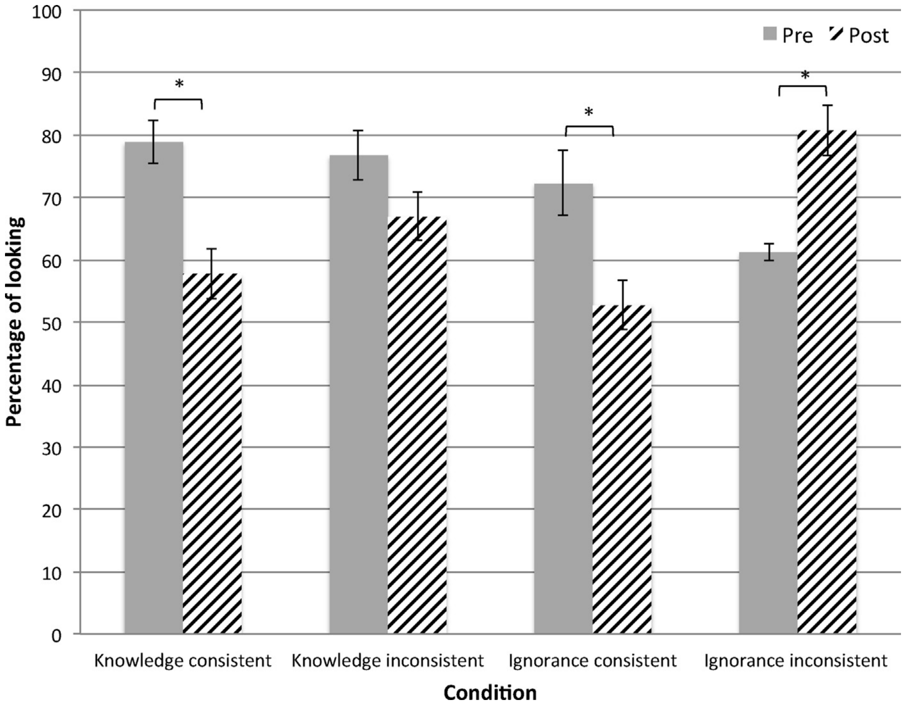

Fig. 2. Percentage of looking at the Speaker AOI in the four experimental conditions during the pre- and post-location name interval. Vertical lines indicate standard error of the mean.

mixed design analysis of variance on the proportion of looking at the Speaker AOI with interval as a within subject variable and knowledge state and language consistency as a between subject variable. Data are illustrated in Fig. 2.

The analysis revealed a significant main effect of interval type and several significant interactions. The main effect of interval type indicates that infants looked proportionally more during the pre- ($M = 0.724$, $SD = 0.189$) than post-location interval ($M = 0.645$, $SD = 0.198$), $F(1, 118) = 11.976$, $p = 0.001$, $\eta_p^2 = 0.092$. There was a significant overall interaction between the interval type, knowledge state and language consistency $F(1, 118) = 9.159$, $p = 0.003$, $\eta_p^2 = 0.072$.

The interval type variable interacted significantly with knowledge state $F(1, 118) = 11.899$, $p = 0.001$, $\eta_p^2 = 0.092$. This effect was largely due to infants looking more at the knowledgeable ($M = 0.779$, $SE = 0.265$) than the ignorant speaker ($M = 0.668$, $SE = 0.269$), $F(1, 118) = 8.738$, $p = 0.004$, $\eta_p^2 = 0.069$ during the pre-location interval, that is, prior to when the location name was spoken. There were no differences between the knowledgeable and ignorant conditions, during the post-location interval, $F(1, 118) = 1.261$, $p = 0.264$, $\eta_p^2 = 0.011$.

However, during the post-location interval, the interval variable interacted significantly with language consistency, $F(1, 118) = 31.189$, $p < 0.001$, $\eta_p^2 = 0.209$. Infants in both conditions looked longer when the language statement was inconsistent ($M = 0.738$, $SE = 0.277$) than when it was consistent ($M = 0.553$, $SE = 0.282$) with speaker's knowledge. There were no differences between interval type and language consistency before the location name, $F(1, 118) = 3.201$, $p = 0.076$, $\eta_p^2 = 0.026$.

The significant overall interaction, motivated us to consider looking across the two intervals for each of the four experimental conditions. As predicted, when the speaker was knowledgeable, infants decreased looking at the speaker from pre- to post-location interval when her statement was consistent with her knowledge ($t(31) = 4.979$, $p < 0.001$), but looked equally across intervals when the statement was inconsistent ($t(29) = 1.434$, $p = 0.162$). In comparing the two knowledge conditions, during the post-location interval, infants looked longer when the said location name was inconsistent ($M = 0.669$, $SE = 0.385$) than when it was consistent ($M = 0.577$, $SE = 0.398$) with the speaker's knowledge of it, $t(60) = 2.544$, $p = 0.014$.

Finally, when we analyzed looking across intervals in the ignorant conditions, infants also decreased looking at the speaker when the ignorant speaker was consistent ($t(29) = 4.594$, $p < 0.001$), but increased looking at the ignorant speaker during the post-location interval when she was inconsistent ($t(29) = -8.593$, $p < 0.001$). In comparing the two ignorant conditions, during the post-location interval, infants looked longer when the said location name matched object's actual location and thus was inconsistent with the speaker's ignorance ($M = 0.807$, $SE = 0.398$), $t(58) = 5.599$, $p < 0.001$ than when it was consistent ($M = 0.528$, $SE = 0.398$).

4. General discussion

The current paradigm introduces a unique way of investigating children's understanding of other's knowledge by asking whether language in itself is understood as a reflection of the speaker's knowledge. The goal of the study specifically was to examine 24-month-olds' understanding of the relation between language and mental states, by testing their looking behavior when the speaker was either knowledgeable or ignorant about an object's final location.

To answer this question we examined whether the same spontaneous and implicit reaction to violations occurs when *language* violates a speaker's knowledge of reality. Thus, we asked whether children would look longer at a speaker when she makes a statement about an object's location that is not in concordance with her knowledge or lack of knowledge of the object's location change and therefore its current location. Unlike previous VoE location change paradigms, which rely on more visually salient behaviors pertaining to a protagonist's intention to look for an object, the current paradigm relied only on the detection of inconsistency between what the person said and her knowledge of the object's location change. Given this particular feature of our procedure, we specifically focus on gaze at the speaker, the true source of consistency or violation thereof. Prior research corroborates with the use of looking time at the speaker as the dependent variable, as it was shown that violations through language, such as during false labeling of common objects, resulted in increased looking at the speaker (Koenig & Echols, 2003). Here we examined children's visual attention at the speaker as the language statement unfolded, which resulted in two key time frames – language statement before and after the location name was spoken. In doing so we asked when during the language statement infants differentiate between conditions – before the location name, based on whether the speaker is knowledgeable or not of the location change, or following the location name, based on whether the speaker's language matched what the speaker knows or doesn't know.

Results indicate that even prior to the detection of violation, that is prior to when the location name is mentioned, young children distinguish between scenarios in which the speaker is knowledgeable and scenarios in which she is ignorant. During the initial part of the statement, infants looked longer at the speaker when she was knowledgeable and focused less on the ignorant speaker. A possible explanation for these findings might be that compared to a speaker who is ignorant, a knowledgeable speaker is a more reliable source of information, thus one that should be attended to. In line with this reasoning, some evidence suggests that during ambiguous situations or when presented with an ambiguous object, 10- and 12-month-old infants look more toward and adjust their behavior according to the information provided by the knowledgeable adult rather than a non-expert (Schmitow & Stenberg, 2013).

Our results also showed that following the location name infants' gaze was influenced by the inconsistency of speaker language to her knowledge state. Infants looked more at the speaker when she mentioned a location name that was inconsistent with her knowledge or lack of knowledge of the object's transfer. Infants decreased their focus on the speaker when the location name was consistent with her knowledge (Knowledge Consistent) or her ignorance (Ignorant Consistent), but they either increased (Ignorance Inconsistent) or maintained their focus on the speaker (Knowledge Inconsistent) across the two intervals when the language was inconsistent. These findings demonstrate that children as young as 24 months of age have an understanding that language expresses the speaker' mental state and is not a direct reflection of what is the current state of reality.

More research is necessary to further investigate the extent to which infants before 2 years show the same reaction to situations where a speaker's language does not match her knowledge state. Do children younger than 2 years of age make epistemic inferences based on language? It is possible that language violations may become more easily detectable by children as their experience with language as a source of information about absent and abstract entities (such as mental states) increases. It has been shown that, only months into their second year, children understand that words can refer to absent objects (Ganea & Saylor, 2013; Ganea, 2005; Saylor, 2004) and that they refer not only to particular objects but also to general kinds (Gelman, Hollander, Star, & Heyman, 2000; Graham, Booth, & Waxman, 2012; Waxman & Gelman, 2010). By the end of their second year of life, children can also utilize language to update object representations in the absence of visual input (Galazka & Ganea, 2014; Ganea & Harris, 2013). Detaching word meaning from direct perceptual input enables children to engage in conversations with others about abstract things, such as mental states as reasons for behavior, thus heightening their awareness of others' epistemic states (Harris, 2006).

The current research shows that 24-month-olds do not evaluate speakers egocentrically, as if they shared the same epistemic perspective. Instead, children distinguish between scenarios in which a speaker is knowledgeable or ignorant and pay increased attention when what the person says is not consistent with her knowledge state. This suggests that by the end of their second year children interpret language as a medium for communication of one's knowledge. However, the range and articulation of epistemic attitudes (belief, guess, doubt) assigned by young children to other speakers with respect to propositional content is not fully known.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.cogdev.2016.07.003.

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