Language background shapes third-party communication expectations in 14-month-old infants

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Abstract

Infants expect native and non-native speech to communicate, i.e. to transfer information between third-parties. Here, we explored if infants understand that communication depends on the use of shared conventional systems (e.g. speaking the same language), and if linguistic input (monolingual vs. bilingual) influences infants' expectations about who can communicate with whom. Fourteen-month-old monolingual and bilingual infants were presented with two actresses who spoke distinct languages (Experiment 1) or the same foreign language (Experiment 2). At test, one of the actresses uttered a foreign-language sentence (*communicator*) to inform the other actress (*recipient*) about her preference for one of two objects she could not reach. Infants expected effective communication between the two actresses when they belonged to the same linguistic group. When they demonstrated to speak distinct languages, however, only bilinguals expected that the communicator's message would be effectively transmitted to the recipient –they found more surprising the condition in which the recipient gave to the communicator the non-preferred object (vs. the preferred). The results suggest that infants expect speech to convey information between third-parties only when individuals

share the same conventional system. In addition, the results suggest that, unlike monolinguals, bilinguals expect speakers of their native-language to have access to multiple conventional systems.

Keywords: communication, language, bilingualism, social affiliation, third-party expectations, infant social cognition

1. Introduction

By their first birthday, infants understand that communication functions as a mechanism to transfer information from one agent to another. Six to twelve-month-old infants expect speech, but not non-speech sounds, to communicate between third parties (Martin, Onishi, & Vouloumanos, 2012; Vouloumanos, Martin, & Onishi, 2014; Yamashiro & Vouloumanos, 2018). In a recent study, Vouloumanos (2018) found that this sensitivity to the communicative nature of speech is not restricted to infants' language experience. Infants expect foreign languages to transfer information between peers, suggesting that they view language as a universal mechanism to communicate.

Effective verbal communication, however, is constrained to the use of shared conventional systems (Clark, 1996). That is, a recipient will be able to interpret speech from a communicator only if she comprehends the language used to convey the message. In Vouloumanos (2018), when infants saw a communicator speaking to a recipient, they did not know the languages that the recipient could speak. Still, participants expected the recipient to understand the communicator irrespective of whether she conveyed the message producing native or foreign speech. These results raise the question of whether infants appreciate that communication is constrained to the used of shared conventional systems, or whether this appreciation requires the support of more fully developed social and linguistic capacities. The current study aimed at addressing this issue.

Critical for communication is the assumption that words are conventional symbols that are shared across speakers of a linguistic community (Sabbagh & Henderson, 2007). Sensitivity to the shared conventional nature of words emerges early

in life (Diesendruck, 2005). By their second birthday, toddlers assume that speakers share the knowledge of object labels (Henderson & Graham, 2005). However, they do not expect members of the same linguistic community to share non-conventional information such as desires for objects (Graham, Stock, & Henderson, 2006), or idiosyncratic personal facts (Diesendruck & Markson, 2001). Even at younger ages, 9 and 13-month-old infants expect speakers to share the same labels for objects, but not to prefer the same objects (Buresh & Woodward, 2007; Henderson & Woodward, 2012).

Importantly, infants' assumptions of conventionality seem to go along with an appreciation that different languages follow distinct conventional systems. By the second year of life, toddlers use language in context-sensitive ways. Bilinguals, for instance, tend to choose to speak the language that the recipient of the message primarily speaks, even when it is not their dominant language (Deuchar & Quay, 1999; Genesee, Boivin, & Nicoladis, 1996). Already at 13 months, both monolinguals and bilinguals represent words as conventions that should not be generalized to speakers of different languages (Henderson & Scott, 2015; Scott & Henderson, 2013).

These findings on infants' sensitivity to the constraints of conventionality support the possibility that infants consider the languages people speak to reason about who can communicate with whom. In Vouloumanos (2018), both monolingual and bilingual infants expected foreign languages to convey information between third-parties (Vouloumanos, 2018). Here, we predicted that monolingual infants would expect an unfamiliar language to communicate if the Recipient speaks the same foreign language, but not if she has shown to speak infants' native-language. However, bilinguals may

expect speakers of different languages to engage in effective communication. Previous studies found that experience to at least two languages influences toddlers' expectations about the languages people may know (Pitts, Onishi, & Vouloumanos, 2015). Twenty-month-old monolinguals expect agents to comprehend only one language. Bilinguals, however, are open to the possibility that others could understand two familiar languages. An open question is whether similar expectations are present earlier in infancy, when communicative skills are less consolidated, and whether they apply to a situation in which one of the languages that people speak is unfamiliar. We addressed this in two experiments.

In Experiment 1 (*E1*), we presented 13-to-15-month-old infants with communicative interactions between speakers of different languages in order to explore their sensitivity to the constraints of communication. We tested both monolinguals and bilinguals to investigate the role of language experience in determining who can communicate with whom. In Experiment 2 (*E2*), the two agents spoke the same unfamiliar language (Hungarian). Adapting Martin et al., (2012), we initially presented participants with an actress (hereafter, *communicator*) who spoke Hungarian and another actress (hereafter *recipient*) who spoke Catalan or Spanish (E1), or Hungarian (E2). Then, the communicator selectively grasped one of two objects (*target*) displayed in the video. Next, the recipient showed no preference by grasping both objects. At test, the communicator could no longer reach the objects. She used speech (Hungarian) to inform the recipient about her preference for the target, who gave either the target or non-target to the communicator. We measured infants' looking times at the screen in each outcome, assuming they look longer at events that violate their expectations. If

infants expected successful communication, they should look longer at the non-target outcome. We hypothesized that monolinguals and bilinguals would expect effective communication between speakers of the same foreign-language (Vouloumanos, 2018), but only bilinguals would consider the possibility that speakers of different languages can communicate (Pitts et al., 2015).

2. Method

2.1. Participants

We recruited 96 infants. E1 comprised 24 monolinguals (M (months;days): 14;13, range: 13;26-15;15, Female: 13) and 24 bilinguals (M: 14;10, range: 13;20-15;13, Female: 11). E2 comprised 24 monolinguals (M: 14;18, range: 13;24-15;15, Female: 13) and 24 bilinguals (M: 14;15, range: 13;20-15;13, Female: 11). A questionnaire adapted from Bosch & Sebastián-Gallés (2001) was administered to determine infants' language background. Monolingual infants were exposed to more than 85% to their dominant language (E1: Mean 95.96%, range: 86%-100%]; E2: Mean 96.5%, range: 86%-100%). Bilingual infants were exposed to their main language up to 75% of the time (E1: Mean 63.8%, range: 50%-75%]; E2: Mean 63.13%, range: 50%-74%). Participants had no exposure to Hungarian before the experiment. Sixty-eight additional participants were tested but excluded from analysis due to inattention (E1: 4 Mon, 3 Bil; E2: 6 Mon, 10 Bil), fussiness or crying (E1: 1 Bil; E2: 2 Mon, 4 Bil), experimental error (E1: 1 Mon, 3 Bil; E2: 4 Mon), parental interference (E1: 2 Mon; E2: 3 Mon, 1 Bil), looking at the screen for the maximum amount of time during both outcomes (E1: 1 Bil; E2: 2 Bil), statistical outliers (looking time difference scores were 2 SDs above or below the mean difference score;

E2: 1 Mon, 2 Bil) or exposure to dominant language between 76% and 85% (E1: 9; E2: 9). Participants were recruited by visiting maternity rooms at two private Hospitals in Barcelona, Spain. All participants were healthy, full-term infants (>37GW). The research reported in this manuscript was conducted in accordance with the principles expressed in the Declaration of Helsinki and approved by the local ethical committee (Clinical Research Ethical Committee Parc de Salut Mar). Written informed consent was obtained before the experiment was conducted.

2.2. Procedure and Materials

Participants were tested in a sound-attenuated room at Center for Brain and Cognition (Universitat Pompeu Fabra). Participants' behaviour was recorded using a Sony HDR-HC9E camera. Infants sat on the caregiver's lap at ~65cm from a 23'' screen (1920 x 1080 pixels). Caregivers were asked to close the eyes when the videos started. Videos were projected onto the screen using Psychotoolbox-3 in MATLAB.

The experiment was structured in four phases presented in the following order: introduction, familiarization, pretest and test (Figure 1).

2.2.1. Introduction

Two actresses appeared at the center of the screen one after the other telling a story: one actress (*recipient*) spoke infants' native language –Catalan (~26s; Movie S1) or Spanish (~23s; Movie S2)– in E1 and a foreign language –Hungarian (~26s; Movie S8)– in E2; the other actress (*communicator*) spoke a foreign language – Hungarian (~25s; Movie S3). Participants' dominant language–either Catalan or Spanish–determined the

language of the Recipient in E1 (16 bilinguals and 12 monolinguals viewed the Catalan-speaker). All bilinguals were exposed to Catalan and Spanish, except for one participant exposed to Spanish and French. Around a third part of the participants in each group saw first the communicator, followed by the recipient. The rest of participants saw the videos in the reverse order. Each trial started with a grey background with a small black cross at the center of the screen (1.5s; *cross scene*).

2.2.2. Familiarization

The communicator was situated behind a wall. Her face and arms were visible through a window at the back of the display and two objects were situated in front of her (a red funnel and a green liquid container). Participants viewed three identical trials in which the communicator's preference for one of the two objects (*target*) was presented (Movie S4). The target and location of the target were counterbalanced. At each trial, the communicator initially looked at a neutral central point of the display (1.5s). She then looked at the object on the left (1.5s) and then at the object on the right (1.5s). Afterwards, she looked and reached for the target (2s) and lifted it in front of her face (1.5s). She then tilted the object back and forth (2s) and remained doing the same action until participants looked away for 2 consecutive seconds or 18 seconds elapsed. Each trial was preceded by a cross scene (first trial: 1.5s; other trials: 1s).

2.2.3. Pretest

The recipient was visible on the right side of the display. The communicator was absent. The red funnel and green container were located in the same position as in the familiarization trials (in front of the recipient). The recipient demonstrated to have no

preference for one object (Movie S5). She initially looked at a neutral center point of the display (1.5s). She then looked at the object on the left (1.5s) and at the object on the right (1.5s). Afterwards, she looked back at the object on the left (1s), reached for and lifted it (2s), tilted it back and forth (2s), placed it back into the floor (1.5s) and removed her hand (1s). The recipient then repeated the same movements with the other object. Then, she remained still (1s) and repeated the interaction with the two objects again. The pretest trial was preceded by a cross scene (1.5s).

2.2.4. Test

Both the communicator and recipient appeared in the scene. In the window at the back of the display only the face of the communicator was visible, and she could no longer reach the objects. The communicator looked neutrally at the centre of the two objects (2s). She then looked at the object on the right (2s), then at the other object (2s) and then she made eye contact with the recipient (1s). The communicator said twice “Ide adnád a “bityét”?” in Hungarian (“Would you give me the “bityét”?) (5s). Participants saw two test trials with the same communicative event, but distinct outcomes: the recipient looked at (1.5s), reached for (1.5s) and approached to the communicator (1s) the target in the *target outcome (Movie S6*) and the non-target in the *non-target outcome (Movie S7*). At each outcome the video paused with the two actresses looking at the raised object until infants looked away 2 consecutive seconds, or until 40 seconds elapsed. The outcome order was counterbalanced. Each outcome was preceded by a cross scene (1.5s) with a bell sound.

2.3. *Coding and Data Analysis*

Following Sommerville, Schmidt, Yun, & Burns (2013) and recent work at our laboratory (Colomer, Bas, & Sebastian-Galles, 2020) statistics were computed on participants' looking time to the screen at the end of each test outcome until they looked away for 1 second consecutively or 40 seconds elapsed[1]. Recordings were coded (using frame as a unit: 1sec = 30 frames) by a primary coder, who was unaware of the hypotheses of the study, and the first author. A high inter-coder agreement was achieved (ICC > .99 E1; ICC > .82 E2). Reported data correspond to the coding of the primary coder. To be included in the analysis, participants had to attend at the screen in the three familiarization trials, in the pretest at least during one action per object and in the test when the Communicator uttered speech and when the Recipient reached for an object (otherwise, they were excluded for inattention). A Shapiro-Wilk test confirmed that looking time data in some cells were skewed, and all data were therefore log-transformed prior to analysis to better approximate a normal distribution. To facilitate comprehension, Figure 2 shows raw looking times. All statistical tests were parametric and two-tailed.

[1] The maximum reported looking time is 42.5s because it includes infants' looking time during the Recipient's action (2.5 seconds).

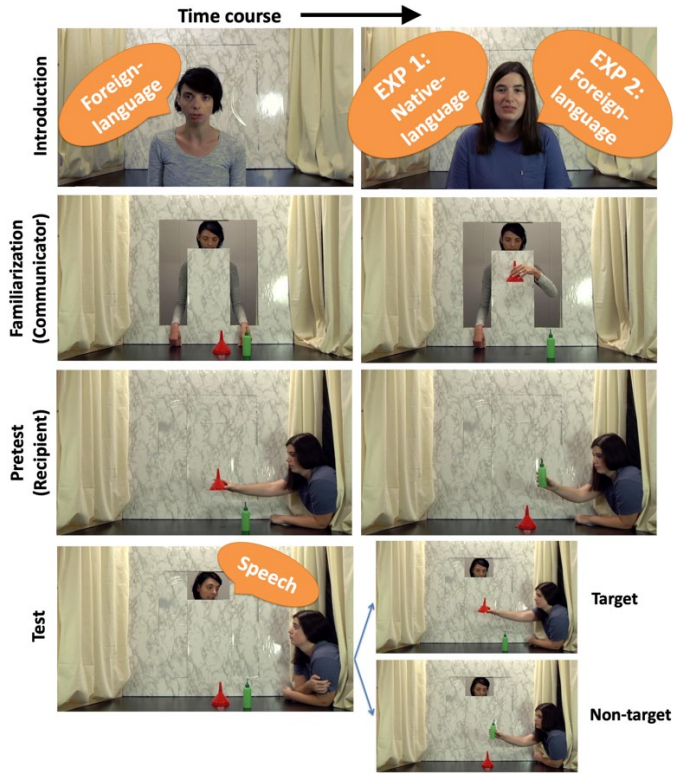

Figure 1. *Stimuli. (Introduction) Each actress tells a story. The communicator speaks a foreign-language (left-column) and the recipient (right-column) speaks either a native-language (E1) or a foreign-language (E2). (Familiarization) The communicator selectively grasps the target object. (Pretest) The recipient grasps both objects. (Test) The communicator utters (foreign) speech to inform the recipient about her preference for the target. The recipient then approaches either the target (target outcome) or the non-target (non-target outcome) to the communicator. The target object, the location of the target and the order of presentation of the outcomes were counterbalanced.*

3. Results

Experiment 1: Preliminary analyses found no effect of infant gender or order of presentation of outcome trials. We computed a mixed ANOVA with outcome type as a within-participants factor (target; non-target) and linguistic profile (Monolinguals;

Bilinguals) as a between-participants factors. We found a significant interaction between linguistic profile and outcome type ($F(1,46)=6.12$, $p=.017$, $\eta_p^2=.12$). Paired t-test indicated that bilingual infants looked significantly longer at screen in the non-target outcome ($M=20.72s$, $SD=10.20$) than the target outcome ($M=14.19s$, $SD=6.59$; $t(23)=3.77$, $p<.01$). However, monolingual infants looked equally when the recipient handled either object ($M_{non\text{-}target}=17.49s$, $SD_{nontarget}=10.14$; $M_{target}=17.12$, $SD_{target}=8.29$; $t(23)=.32$, $p=.75$; Figure 2A). In order to confirm that differences in the test due to bilingualism were not driven by general attentional differences, we run an ANOVA with linguistic profile as between-participants factor and mean looking time in familiarization trials as dependent variable. We found no effect of linguistic profile ($F(1,46)=1.45$, $p=.23$, $\eta_p^2=.031$),

A simple linear regression model was calculated to investigate if infants' difference in looking time between outcomes (non-target – target) could be predicted by the percentage of exposure to infants' dominant language (50%-100%). Recent work suggests that infants' looking time is not simply a binary measure (looking more or not?), but it should rather be interpreted as continuous (Sim & Xu, 2019). The model included previously excluded participants (2) because of their linguistic profile (exposure to main language between 76%-85%). A significant relationship between looking difference and percentage was found ($F(1,48)=6.031$, $p=.018$; $R^2=.093$). The model indicated that the higher was the exposure to infants' main native-language (more "monolingual"), the smaller was the difference in looking time between the non-target outcome and the target outcome (Figure 2B).

Experiment 2: The analysis plan was pre-registered before completing data collection (https://osf.io/xaqzw). Upon request of the reviewers, we ran preliminary analyses with gender and order of presentation. We found no effect of infant gender. The order of presentation of test outcomes influenced infants' looking time at each test outcome and we included it as a variable. We ran a mixed ANOVA with outcome type as a within-participants factor (target; non-target) and linguistic profile (Monolinguals; Bilinguals), and outcome order (first target; first non-target) as a between-participants factors. We found a significant interaction between test order and outcome type ($F(1,44)=4.74$, $p=.035$, $\eta_p^2=0.038$) and a main effect of outcome type that tended to significance ($F(1,44)=3.93$, $p=.054$)[1]. Paired t-tests indicated that infants looked significantly longer at the non-target outcome (M=16.75s, SD=6.81) than at the target outcome (M=12.85s, SD=5.36s) when they first saw the non-target trial ($t(1,23)=3.1$, $p=.005$), but not otherwise ($p>0.1$).

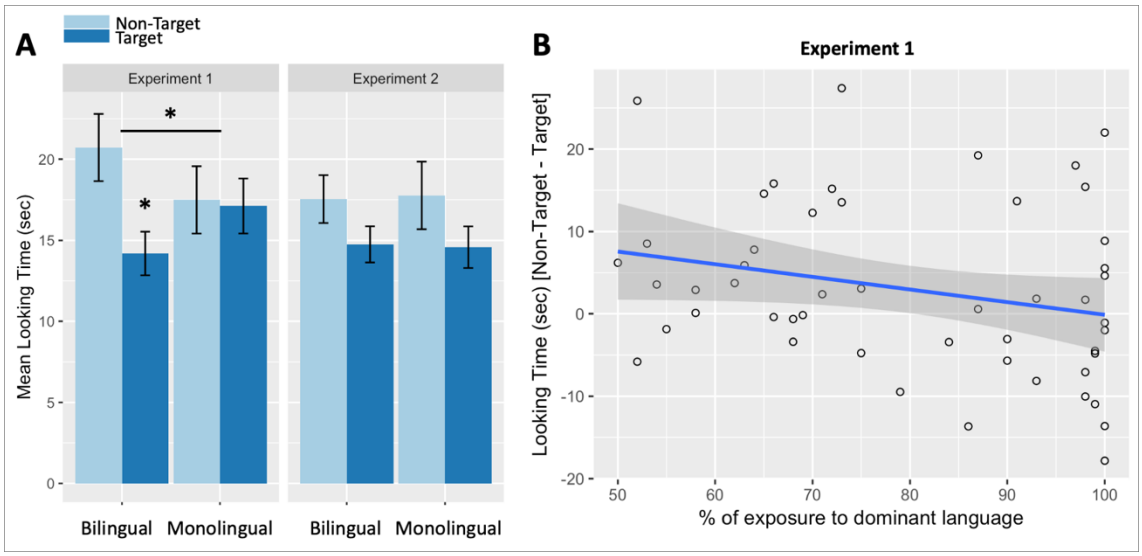

Figure 2. Results. (A) Mean looking time (in seconds) and standard error of the mean for each outcome type (Target: dark blue, Non-target: light blue) for each language group

[1] In the preregistration, we specified that we would not log-transform the data. However, after running analyses testing for normality, we found compelling evidence that our data was not normally distributed. The main effect of outcome type in Experiment 2 without log-transformation was significant $F(1,44) = 5.43$, $p = 0.024$.

and Experiment. An asterisk (*) indicates significance at p < .05 ***(B)*** *Linear regression model of the difference in looking time between the Non-target outcome and the Target outcome in E1 across the percentage of exposure to the dominant language. Each small circle represents data from a participant. The blue line represents the linear regression function. The blur area around the line represents the 95% confidence level interval for predictions from a linear model ("lm").*

4. Discussion

We investigated if 14-month-old monolinguals and bilinguals expect information to be efficiently conveyed between speakers of different linguistic communities (E1) or speakers of the same foreign linguistic community (E2). A communicator (foreign-language speaker) used speech to inform a recipient (native-speaker in E1; foreign-speaker in E2) about her preference for a target object. In E1, bilinguals looked significantly longer at the screen when the recipient presented the communicator with the non-target instead of the target, suggesting that they expected the recipient to understand the communicator's message. In contrast, monolinguals looked similarly at the screen in both outcomes, suggesting that they did not expect speech to transmit information between speakers of different languages. A regression model found that the effect of bilingualism did not depend merely on exposure to another language. The more frequently infants were exposed to multiple languages, the more enhanced was their expectation that speakers of different languages would communicate successfully. In E2, in line with the results of Vouloumanos (2018), no differences were found based on

bilingualism. In general, participants tended to look longer at the non-target outcome as compared to the target outcome (see SI for an extended discussion).

Previous studies found that by the end of the first-year infants expect both native and foreign speech to transfer information between third-parties (Martin et al., 2012; Vouloumanos, 2018). Here, we extended these findings by showing that infants expect communication to be constrained to the use of shared conventional systems. In addition, our results indicate that the language environment infants are exposed to influences their expectations about who can communicate with whom. Bilinguals expect speakers of their native language to comprehend a non-native language; monolinguals do not.

Why did bilinguals in E1 expect the recipient to comprehend foreign speech? One possibility is that, unlike monolinguals, they did not expect different languages to follow distinct conventional systems. However, previous findings suggest the opposite: 13 to 24-month-old bilinguals tend to have an enhanced sensitivity about the constraints of conventionality, as compared to monolinguals (Byers-Heinlein, Chen, & Xu, 2014; Henderson & Scott, 2015). A more plausible possibility is that bilinguals expected a speaker of their linguistic community to comprehend more than one language. Consistently with this idea, Pitts et al., (2015) found that 20-month-old monolingual and bilingual toddlers hold different expectations about who can communicate with whom: bilinguals consider the possibility that people may comprehend two familiar languages, whereas monolinguals evaluate others as monolinguals. Here, we found that already in infancy bilingualism influences infants' reasoning about the languages people speak.

Bilinguals expect that a speaker of their native-language will comprehend a foreign-language, even if they have never been exposed to this language; monolinguals do not.

In E1, however, we found a reversed pattern of results as compared to Pitts et al., (2015). Monolinguals looked similarly at both test outcomes (vs looking longer at the non-target). Bilinguals looked longer at the non-target (vs looking similarly at both outcomes). Differences in the experimental design between Pitts et al. (2015) and our study could account for the distinct looking behaviors. First, we designed a within-subjects rather than a between-subjects study. The first outcome trial that infants saw could influence their expectations about the Recipient's actions in the second trial. In contrast to this idea, we found the same pattern of results when running statistics on the first outcome trial (between-subjects) as when we considered the two trials that infants saw (within-subjects). In the between-subjects analysis, bilinguals also looked longer at the non-target outcome (M=25.26s) than the target outcome (M=12.6s; $t(1,11)=2.61$, $p=0.024$); monolinguals looked similarly at both ($t(1,11)=0.5$, $p=0.62$). The experimental design was also distinct between studies in that in Pitts et al. (2015) the Communicator always spoke a language that was familiar to bilinguals, and the Recipient never talked. In our study, however, we investigated how infants reasoned about communication events that included a foreign language, when explicitly showing them that the Recipient was from their linguistic community. Our results suggest that infants generalize their experience with communication acts in their native-languages to reason about novel and unfamiliar communicative events.

Another difference between Pitts et al. (2015) and our study is that we tested younger participants. At 14 months, bilingual infants could have not learned yet that people may be or may not be multilingual. However, 20-month-old toddlers may have sufficient experience with other people to know that they do not always speak more than one language. The results of monolinguals also suggest a developmental change in their looking behaviour. When 12-month-old infants do not expect communication between individuals –such as we predicted for monolinguals in E1– they tend to show equivalent looking times at target and non-target outcomes (Martin et al., 2012; Vouloumanos, 2018; Yamashiro & Vouloumanos, 2018). However, 20-month-old toddlers tend to look longer at the outcome that would be consistent with a successful transmission of information (target outcome). The developmental change in infants' looking behavior suggests that across the second year of life they learn information critical to generate more robust and accurate predictions about novel communicative events.

One alternative interpretation of the current results is that bilinguals expected members of different linguistic communities to cooperate, but monolinguals did not. Previous studies suggest that by 17 months infants possess an abstract expectation of in-group support (Jin & Baillargeon, 2017). Infants expect two adults who belong to the same group, but not members of different groups, to help each other rather than to ignore them. Although it is on debate whether infants use language as a social marker of group membership (Begus, Gliga, & Southgate, 2016; Liberman, Woodward, Keysar, & Kinzler, 2017), there are some studies suggesting this might be the case (Liberman, Woodward, & Kinzler, 2017). However, unlike other investigations, we presented a situation in which the recipient never ignored the communicator's request: she always

presented the communicator with an object. It is unlikely that infants interpreted the non-target outcome as the recipient being antisocial, instead of just trying to help but being wrong.

Communication and affiliation are generally linked. People who is more likely to communicate is also more likely to affiliate. In a previous study, 9-month-old monolinguals expected same-language speakers to be more likely affiliated than distinct-language speakers (Liberman, Woodward, & Kinzler, 2016). The authors main interpretation was that infants formed inductively-rich social categories based on language. However, the authors also acknowledge that their results could be driven, in part, by infants' capacity to infer that people who share the same conventional system is more likely to communicate. Our findings show that this capacity is present in infancy and suggest that infants can use information about who can communicate with whom to predict third-party interactions. Similarly, infants' early reasoning about social groups could influence their expectations about how members of the same or a different linguistic group are likely to respond to others' requests.

Much of the information infants learn about the world is acquired through the observation and interaction with other social agents (Csibra & Gergely, 2009; Poulin-Dubois & Brosseau-Liard, 2016). Holding a sophisticated appreciation of the conventional nature of language and its communicative function is likely to provide a fundamentally basis for social learning. The current study provides evidence that a sensitivity to the communicative function of speech and its constraints is present by 14 months and it is shaped by language background.

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