JOURNAL OF COGNITION AND DEVELOPMENT
2022, VOL. 23, NO. 2, 273–288
https://doi.org/10.1080/15248372.2021.1966013

Routledge
Taylor & Francis Group

The Propensity to Learn Shared Cultural Knowledge from Social Group Members: Selective Imitation in 18-month-olds

Nazlı Altınok[a], Ildikó Király[a,b], and György Gergely[a]

[a]Central European University, Hungary; [b]Eötvös Loránd University, Hungary

ABSTRACT

Fourteen-month-olds selectively imitated a sub-efficient means (illuminating a lightbox by a head-touch) when this was modeled by linguistic ingroup members in video-demonstrations. A follow-up study with slightly older infants, however, could replicate this effect only in a video-demonstration context. Hence it still remains unclear whether infants' apparent tendency to be selective in learning opaque manners of novel skills from linguistic ingroup members is, indeed, a characteristic constraining property of cultural knowledge transmission that can be reliably manifested in live demonstration contexts that are more representative of naturalistic learning environments. To answer this question, we aimed to replicate the original study using live demonstration with a group of older infants (N = 48; 28 females). We found that eighteen-month-olds imitated the opaque manner of sub-efficient means action as a function of whether the demonstrator was a speaker of their own language. In a no-demonstration control group, infants relied on the self-discovered efficient means (hand-action), just like infants observing the foreign speaker. These findings suggest that selectivity in learning sub-efficient opaque actions from linguistic ingroups has evolved to support transmission of culture-specific manner of action practices shared within social groups.

Humans are unique in their capacity to acquire and faithfully transmit culturally shared action routines. Given their cognitively opaque and arbitrary characteristics, while acquiring such customary, normative and sub-efficient action routines, naïve learners mostly rely on demonstrations by knowledgeable others (Gergely & Csibra, 2006). As shown by previous research, ostensive communicative signals (e.g., establishing eye contact and being addressed by infant directed speech) have a special role in aiding infants' acquisition of cognitively opaque information (Csibra & Gergely, 2006, 2009; Gergely, Egyed, & Király, 2007). Ostensive signals facilitate infants' learning about the functions of novel tools despite the opacity of their demonstrated manner of operation and the manifested function served by the novel artifacts (Futó, Téglás, Csibra, & Gergely, 2010). They also help infants to form novel means-actions representations (Hernik & Csibra, 2015), highlight the hidden dispositional properties of objects (Kovacs, Téglás, Gergely, & Csibra, 2017), and contribute to their learning of seemingly arbitrary manner of sub-efficient actions (Brugger, Lariviere, Mumme, & Bushnell, 2007; Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; Király, Csibra, &

CONTACT Nazlı Altınok altinok.nazli@gmail.com Cognitive Development Center, Central European University, Oktober 6 Utca 7, Budapest 1051, Hungary
Supplemental data for this article can be accessed on the publisher's website.

Gergely, 2013; Kupán et al., 2017). Ostensive signals achieve this by conveying to the addressee the demonstrator's communicative intention to transfer relevant and new knowledge. They induce "epistemic trust" (Gergely et al., 2007) and a "presumption of relevance" (Sperber & Wilson, 1986) in their addressee who then interprets the informative content of the agent's communicative demonstration as conveying relevant generic knowledge that is shared by other agents, generalizes across situations, and applies beyond the *here-and-now* (Csibra, 2010; Csibra & Gergely, 2006, 2009).

However, relying on someone's manifested communicative intention alone does not necessarily guarantee that the informative content of the ostensive communication is the most relevant piece of knowledge for a novice to acquire. Infants in fact show readiness to pick up signals indicating epistemic unreliability of the informants as indicated by their incompetence (Zmyj, Buttelmann, Carpenter, & Daum, 2010), inaccuracy (Brooker & Poulin-Dubois, 2013; Poulin-Dubois, Brooker, & Polonia, 2011) or uncertainty (Birch, Akmal, & Frampton, 2010). Moreover, informants might belong to a different cultural group than the novice. Hence observing an agent's manifestation of communicative intention (by using ostensive signals) might not always warrant that the content of her informative intention is relevant to one's goal of learning new and culturally shared information. Indeed, from early on in ontogeny naïve learners also demonstrate epistemic vigilance (Sperber et al., 2010) and could rely on additional cues of relevance, if available, to judge whether the information presented to them is relevant for their own learning goals and whether the communicator is a reliable source of information.

One direct social cue signaling that the information is likely to be culturally relevant and hence worth acquiring is the language the informant speaks. Previous research showed that by the age of six months, infants prefer the speakers of their own language (Kinzler, Dupoux, & Spelke, 2007). They pay more attention to the novel objects (Marno et al., 2016) and tunes (Soley & Sebastián-Gallés, 2015) when these are introduced by their own language speakers than by foreign language speakers. At 10 to 12 months of age, infants also show selectivity in their object and food choice behaviors as a function of the language the experimenter speak (Kinzler et al., 2007; Shutts, Kinzler, McKee, & Spelke, 2009). While it is still a matter of controversy (Begus, Gliga, & Southgate, 2016; Kinzler & Liberman, 2017), one likely function that this early sensitivity serves is to direct infants' attention toward the informant who might potentially provide them with the most relevant information (Begus et al., 2016). Infants' expectation of relevant information from agents sharing the same language with them has so far only been documented in a single behavioral paradigm showing 14-month-old infants' preferential learning from televised demonstrators speaking the same language as theirs (Buttelmann, Zmyj, Daum, & Carpenter, 2013; but not in live demonstration contexts with 19-month-olds, Howard, Henderson, Carrazza, & Woodward, 2015).

The goal of the present study is to generate further evidence to test infants' epistemic reliance on the cue of whether the informant speaks their own versus a foreign language when evaluating the cultural relevance of the new information demonstrated for them by replicating the study of Buttelmann et al. (2013) and by applying relevant additional measures to the data to extend and elaborate further the interpretation that the results provide support for. We hypothesized that infants would readily acquire novel manners of opaque sub-efficient action skills if these are ostensively demonstrated to them by informants speaking their own language. Furthermore, we conjectured that they would do so

even if they can themselves discover and perform a more efficient alternative means action through which they can achieve the same outcome as by applying the opaque manner of practice manifested to them by the demonstrator. We argue that this early propensity to rely on a presumption of relevance in relation to novel information ostensively demonstrated to them by same-language speakers enables naïve learners to acquire cognitively opaque forms of social practices, conventions, and customs shared and practiced by their cultural group. According to this proposal, it is not simply instrumental *rationality* that leads them to reenact and acquire ostensively demonstrated novel skills by taking into account the situational constraints of the informants when evaluating the causal efficiency of the manifested actions (rational imitation: Gergely, Bekkering, & Király, 2002; Király et al., 2013). Naïve cultural learners can also rely on different social cues to interpret the epistemic constraints that qualify the reliability of the demonstrator as a source of culturally relevant information and use that to modify whether to reenact and acquire the novel cultural information manifested for them. Speaking an unfamiliar foreign language is one example of such an epistemic cue that can signal the infant that the speaker may be an unreliable epistemic source from whom to learn about the common cultural practices and manners of acting that characterize the shared behavioral repertoire of the agents that belong to the infants' social group. If infants are indeed sensitive to and rely on the foreign-language use of the demonstrator as an indicative cue that he or she may be an unreliable cultural informant, they may selectively inhibit their tendency to reenact and acquire the cognitively opaque behavioral manner of action demonstrated to them ostensively by the foreign language speaking agent. In contrast, we predict that infants will be more likely to show high fidelity reenactment of the cognitively opaque manner of action if it is manifested to them by a demonstrator speaking the same language as their own social community which makes them consider the cognitively opaque manner culturally relevant.

To test this hypothesis, we replicated the procedure of Buttelmann et al. (2013) with two exceptions: in our study the opaque means action was presented in a live demonstration (instead of video-demonstrations) and it was presented to 18-month-old infants (an older age range where selective imitation has been found, see Gellén & Buttelmann, 2019; but not as a function of the demonstrators speaking a different language, Howard et al., 2015). Infants first either observed a live demonstrator telling them a story in their own language or in a foreign language. Then the same demonstrator (whose hands were free) performed a head-touch action to operate a touch sensitive lightbox while using non-verbal communicative ostensive signals addressing the infant. After this, the demonstrator left the room leaving the infants alone with the target apparatus. We also tested a third group of infants who participated in a control condition where there was no head-touch action demonstration.

Not using video demonstrations allowed us to have both demonstrators socially and ostensively engage with the participants in a non-verbal face-to-face interaction which allowed us to replicate Buttelmann et al.'s (2013) original study in a live context and with slightly older infants. In particular, it also allowed for testing Howard et al.'s (2015) alternative interpretation based on their later findings which indicated that 19-month-old infants only imitate the opaque head-action selectively as a function of same versus foreign language speaking models when the demonstrations are presented in a video-recorded televised context. According to their interpretation due to their socially more engaging nature the live presentations delivered by directly communicating models may induce higher arousal in the infants which, in turn, may make it more difficult to them to selectively inhibit (due to the demonstrator's earlier use of a foreign

language) their tendency to imitate the model's ostensively manifested actions. On this account, the live demonstration contexts used in the present study would be expected to make it less likely that the older group of infants we tested would show selective imitation as a function of the same versus foreign language used by the model. While the arousal hypothesis discussed at length by Howard et al. (2015) seems to go against the "video-deficit" account, a term coined to refer to the reduced imitation performance of children presented with video demonstrations in contrast with live demonstrations (Anderson & Pempek, 2005), it emphasizes the possibility that infants may have a harder time inhibiting the information which was just presented to them live by socially engaging informants in ostensive demonstration contexts.

Methods

Participants

Participants were 48 infants (28 females). Mean age of the infants was 577.23 days (18 months 29 days) (range 549–607 days; 18;2 to 20 months; *SD* = 16.8 days). An additional 19 infants were tested but excluded due to being fussy (n = 7) or passive (n = 7) (i.e., they did not touch any part of the apparatus), experimenter error (n = 1), parental interference (n = 3) and having a regular weekly exposure to a foreign language (n = 1). All infants in the experimental conditions were monolingual, learning only Hungarian as their native language.

Participants were recruited from a database of parents who volunteered to participate in developmental studies. Each parent gave his or her written informed consent for the study, and the procedure was approved by the Central European University's United Ethical Review Committee for Research in Psychology and conducted in accordance with the Declaration of Helsinki.

Design

Infants were randomly assigned to three conditions: same-language speaker demonstration (N = 16 [10 females], M_{age} = 577.87 days, SD = 17.56), foreign-language speaker demonstration (N = 16 [8 females], M_{age} = 573.69 days, SD = 18.04), and no-demonstration (N = 16 [10 females], M_{age} = 580.12 days, SD = 15.06).

Materials

The lightbox apparatus was a circular touch-sensitive lamp with a diameter of 13 cm mounted on a black box with the dimensions of 24 × 16 x 4.5 cm. The lamp lit up when pressed on the surface and remained illuminated until released.

Procedure

To make sure that the participants, independently of which experimental condition they were allocated to, had equal exposure to both demonstrators before the start of the experiment, both demonstrators interacted with the infant in a free-play context for approximately five minutes in the common waiting area before the experiment began. For the no-demonstration condition, this free play activity was not carried out.

For the experimental conditions, the procedure consisted of a demonstration and a response phase. Upon entering the testing room, infants were seated on the parent's lap in front of a small table. For both the same-language and foreign-language speaker conditions, the demonstrator sat down at the other side of the table facing the infant, greeted him or her by saying "Hi baby hi, how are you? Now I am going to tell you a story" and went on to narrate a story. Depending on which condition the infant was assigned to, she or he either observed the demonstrator's ostensive and verbal greeting and heard the story told in her own language (in Hungarian) or in a foreign language (in Turkish). The story was taken from the study of Buttelmann et al. (2013) (see supplementary material). Both demonstrators were native speakers of the respective languages, and had similar physical features (white skin tone, dark hair, and brown eyes).

After the story-telling event, the demonstrator reached under the table for the lightbox apparatus and put it on the table in front her, out of the infants' reach. After placing her hands visibly on the table next to the two sides of the apparatus the demonstrator leaned forward and touched the surface of the lightbox with her forehead maintaining contact with it for two seconds during which time the lightbox was illuminated. After having induced the light-effect by her head-touch action she looked at the infant, smiled and placed her hands back onto her lap. She then again visibly placed her hands on the table resting at the two sides of the touch-lamp, smiled at the infant, and leaned forward again to touch the lightbox with her forehead demonstrating the same sub-efficient head-touch action once more. There were three such consecutive non-verbal demonstrations in total that lasted approximately 20 seconds. After the demonstration phase, the demonstrator pushed the lightbox toward the infant without saying anything and left the room. Infants were given a 20-seconds response period to manipulate the lightbox. See Figure 1 for the visual depiction of the experimental set-up used both in the same- and foreign-language speaker conditions.

For the no-demonstration condition, the experimenter escorted the dyad into the testing room, and she pushed the lightbox that was placed on the other end of the table to the other side to be in front of the infant in the same manner as in the experimental conditions and then left the room.

Coding

We coded whether infants acted on the lightbox with their heads or their hands, and the order in which they did so. We additionally coded whether any actions that the infants performed were successful in bringing about the light effect. We followed the coding protocol of Meltzoff's (1988) and Király et al.'s (2013). The 20-seconds-long response period started as soon as the infant touched any part of the apparatus. A head-touch action was coded either when there was a clear contact between the surface of the lightbox and the head or when there was a clear attempt to lift up the box toward the head or to lean forward on it with the head, which resulted in decreasing the distance between the head and the lightbox to be 10 cm or less. A hand touch action was coded when there was a clear contact between the surface of the lightbox and the infant's hand. Exploratory hand behaviors, such as grasping or pulling the sides of the lamp in an attempt to separate it or move it from the base of the apparatus, were not coded as hand-touch action. Note

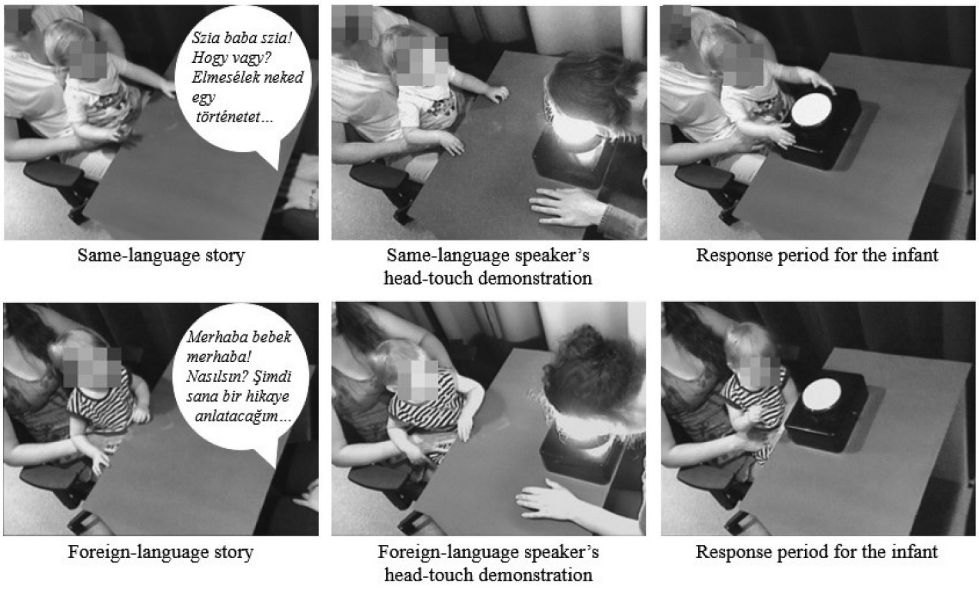

Figure 1. Experimental set-up for the same- and the foreign-language speaker conditions.

that such exploratory behaviors only took place in the no-demonstration condition (see supplementary material for the depiction of the infants' different exploratory hand behaviors on the apparatus).

Further, we coded the frequency of hand and head touch actions. An action was considered to have ended when the hand (or the head) of the infant was retracted from the surface of the lightbox (or for action attempts, when the infant leaned back away from the box), and a second action began when she or he touched the surface again (or for action attempts, when the infant clearly leaned toward the lightbox which resulted the distance between her or his forehead and the surface of the box to be 10 cm or less). Frequency coding was carried out independently of whether any of the actions caused the lightbox to light up or not.

We also calculated the latency of responding by registering how much time has passed from the moment the demonstrator put the apparatus in front of the infant until the infant's first touch of the apparatus.

Approximately 30% of the data (n = 15 infants, 5 from each condition) were coded offline by a naïve blind coder who only watched the response period. Inter-rater agreement was excellent (Cohen's Kappa = 1) for the binary coding of head and hand actions, the order in which these were performed by the infant, and whether there was a light effect achieved during the response period at least once. Inter-rater agreement was excellent for the frequency of head-touches ($r = 1$, $p < .001$) and very high for the frequency of hand-touches ($r = .94$, $p < .001$). Inter-rater agreement on latency measurement was high ($r = 1$, $p < .001$), and the mean absolute difference between the two codings was 113.73 ms (SD = 184.2 ms).

Results

We first analyzed whether there is any difference in the percentage of time infants attended to the story-telling events and the demonstrations in the experimental conditions, along with the latency with which infants acted on the box in the three conditions. This was done to make sure the infants in the two experimental conditions equally attended to the story-telling events and the head-touch demonstrations given that the demonstration for each experimental condition was delivered by a different adult, and to explore any differences in the latency with which infants acted on the box depending on the condition.

Overt attention to story-telling events and to demonstrations, and response latency

The percentage of time the infants attended to the demonstrator while she was telling the story was not statistically significantly different between the experimental conditions (t (29) = 1.68, p = .1; Mann-Whitney U = 80.5, p = .12). In fact, infants in both conditions looked at the demonstration for its entire duration (medians in both conditions = 100%). A one-way ANOVA revealed a statistically significant difference in the latency with which infants acted on the lightbox between the three conditions of same-language speaker, foreign-language speaker and no-demonstration (F (2, 44) = 3.41, p = .04, partial η^2 = .13). A Tukey post hoc test showed that infants took more time to start operating the lightbox after the demonstration by the foreign-language speaker (M = 10.51 s, SD = 14.96) than infants in the no-demonstration condition (M =.93 s, SD = 1.82; p = .04), but not than infants in the same-language speaker condition (M = 7.55 s, SD = 10.54: p = .71). There were no differences in the latency with which infants started to act on the lightbox between the same-language speaker and the no-demonstration conditions (p = .19). The foreign language spoken by the demonstrator did not lead the infants in the foreign-language speaker condition to take more time to act on the box in comparison to the infants in the same-language condition.

Selective imitation of head-touch action on the lightbox

Despite attending equally to the head-touch demonstrations delivered either by the same language speaker or the foreign language speaker, more infants imitated the head-touch demonstration in the same-language speaker condition. There were 13 infants (81%) in the same-language speaker condition and there were only four infants (25%) in the foreign-language speaker condition who acted on the lightbox with their heads at least once during the response period (see Figure 2). All imitative head-touch responses were faithful reenactments of the demonstrated head-touch action (i.e., none of these responses involved strongly emulative variants such as attempting to lift the lightbox by hand to their head to make head-box contact). In the no-demonstration condition, despite not viewing a head-touch action on the lightbox, there were two infants (12.5%) who acted on the lightbox with their heads. To test whether the number of infants performing a head-touch response was affected by condition, Fisher's exact tests were run with a Bonferroni correction for multiple comparisons (p = .016). There was a significant difference between the experimental conditions (p = .004). Furthermore, the number of infants performing the head-touch

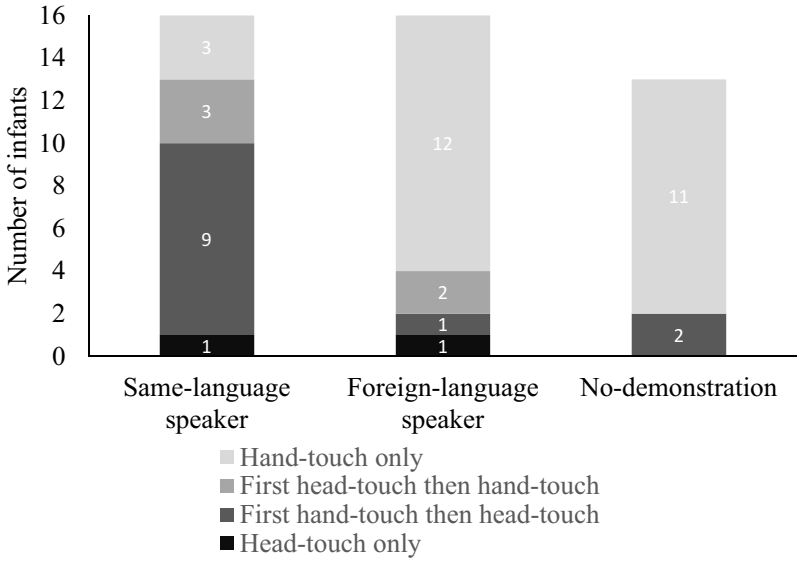

Figure 2. The number of infants who displayed only head-touch action, first hand-touch and then head-touch action, first head-touch and then hand-touch action, and only hand-touch action in three conditions. Note there were three infants in the no-demonstration condition who did not act on the lightbox with a hand- or a head-touch.

action was also significantly different between the same-language speaker and no-demonstration conditions (p = .0002), but not between the foreign-language speaker and no-demonstration conditions (p = .65).

Not all actions infants performed were successful in bringing about the light-effect. In the same-language speaker condition there were 15 infants who successfully brought about the effect at least once, in the foreign-language condition there were 13 such infants, and in the no-demonstration condition only eight infants succeeded in illuminating the lightbox. Binary logistic regression indicated that condition was a significant predictor for whether infants brought about a light effect or not, $\chi^2(2) = 8.88$, p = .01. The model explained 25.0% (Nagelkerke R^2) of the variance in bringing about the light effect correctly classified 75.0% of cases. This finding was followed up with one-tailed Fisher's exact tests given that we predicted lower rates of successful attainment of the effect in the no-demonstration condition in comparison to the experimental conditions. There was a significant difference in the number of infants bringing about the light effect between the same-language speaker condition and the no-demonstration condition (p = .007), and a trend between the foreign-language speaker condition and the no-demonstration condition (p = .067). There was no significant difference between the two experimental conditions (p = .3).

Performing the head-touch action even after bringing about the light effect by a hand-action

Critically to our hypothesis, we investigated the number of infants who acted on the lightbox with their heads despite having already successfully brought about the light effect earlier by using their hand to touch the box. There were 9 infants in the same-language condition who

reenacted the head-action even after having performed a successful hand-action. In contrast, in the foreign-language speaker condition if infants were successful to bring about the light effect with their hands first, none of them performed the head-action later. Binary logistic regression indicated that the experimental condition was a significant predictor for whether infants performed a head-touch action after illuminating the box with their hands ($\chi^2(1) = 16.09$, $p < .001$). The model explained 57.0% (Nagelkerke R^2) of the variance in head-touch response after a successful hand action and correctly classified 78.1% of cases.

Frequency of hand-actions and head-touch actions to operate the lightbox

We calculated the ratio of head-touch to hand-touch actions for each infant in the three conditions (for the raw mean frequency of head and hand actions see supplementary material).

As Figure 3 shows the mean ratio of head versus hand actions was .47 ($SD = .61$) in the same language speaker condition, .19 ($SD = .45$) in the foreign-language speaker condition, and .11 ($SD = .29$) in the no-demonstration condition. A Kruskal-Wallis test indicated a statistically significant difference in the mean ranks of head to hand ratios between the three conditions ($\chi^2(2) = 11.62$, $p = .002$). We followed up this difference with three non-parametric tests (significance level was Bonferroni corrected, $p = .016$). There was a significant difference in the head to hand action ratios between the same-language and foreign-language conditions (Mann-Whitney $U = 53.5$, $p = .008$), and between the same language and no-demonstration conditions (Mann-Whitney $U = 39$, $p = .003$). There was no difference in the head to hand action ratios between the foreign-language and no-demonstration conditions (Mann-Whitney $U = 92$, $p = .82$).

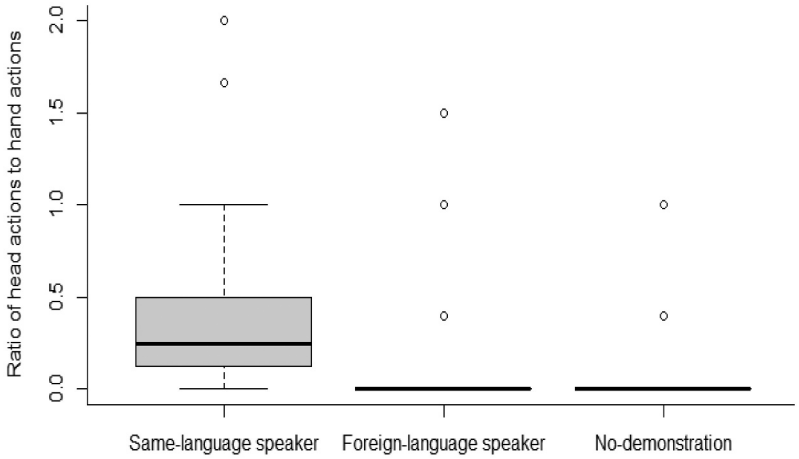

Figure 3 Boxplot for the ratio of head to hand actions by infants in the same-language speaker, the foreign-language speaker, and the no-demonstration conditions.

Discussion

The present study investigated selective imitation in 18-month-old infants of a cognitively opaque and sub-efficient novel means action as a function of whether it was ostensively manifested to them by a same-language speaking versus a foreign-language speaking demonstrator. The study aimed to replicate Buttelmann et al.'s (2013) selective imitation finding using a live presentation procedure and testing a slightly older group of infants. We hypothesized that an ostensive demonstration of a cognitively opaque and sub-efficient novel means action, such as lighting up a touch-sensitive lamp by contacting it with one's forehead, will induce differential degree of reenactment and learning as a function of the language spoken by the demonstrator. We hypothesized that same-language use would be a powerful cue that infants could rely on to identify the epistemic reliability of the demonstrator as a competent source of cultural knowledge when evaluating whether the novel opaque action is relevant for them to reenact and acquire as part of shared cultural knowledge of their social group.

Our results replicate Buttelmann et al. (2013) findings with a sample of older infants tested using a live demonstration paradigm. In line with our hypothesis, we found selective imitation of a cognitively opaque and sub-efficient novel means action as a function of the language the demonstrator spoke. Critically, the language the demonstrators spoke had an independent effect from the ostensive nature of their action demonstrations. As in the original study of Buttelmann et al. (2013), infants viewed the informant who told them a story in their own language or in a foreign language before the demonstration took place. Furthermore, the demonstrations were performed equally ostensively by using identical non-verbal communicative cues addressing the infants. Thus, infants could infer that both models had the informative intention to convey new and relevant information (of the same content) to them independently of what language they spoke during the story-telling phase. In spite of this, infants took into account whether the demonstrators initially revealed themselves as speaking the same language as their own social group or a foreign language and reenacted their respective demonstrations selectively as a function of the language used by the adult model, even though they operated the lightbox in the absence of the demonstrator. Further, the language the demonstrators spoke did not result in any difference in the overt attention infants deployed toward the two demonstrators. Despite not having a single bilingual demonstrator to act as a model for both conditions (for excluding the possibility that the individual differences of the demonstrators could influence infants' imitative behavior as discussed in Howard et al., 2015), we found that infants did not selectively attend more to one demonstrator than the other either during the story-telling phase or during the demonstration.

With this study, we also extend the original work on which our procedure was based by incorporating additional measures, such as hand actions and the relative frequency of head versus hand actions. Buttelmann et al. (2013) reported that all infants both in the same- and foreign-language conditions acted on the box with their hands at least once, but did not document when and how frequently such hand-actions were performed in the response period. On the assumption that infants consider the goal of the demonstration purely from the instrumental point of view and evaluate the causal efficiency of achieving the light effect, there appears to be no reason for them to faithfully reenact the demonstrated sub-efficient head-action, especially given that they have already discovered

a more efficient alternative means action and have in fact successfully operated the lamp with their hands obtaining the same effect. In spite of this, approximately half of the infants in the same-language speaker condition (n = 9) proceeded to light up the lamp by reenacting the sub-efficient head-touch action demonstrated, even though they have already succeeded to bring about the light effect with their hands before. Remarkably, in the foreign-language speaker condition, infants did not show a similar pattern: in fact, only one infant operated the box with her head after having performed a hand action, and for that infant this first hand-action attempt was not successful in illuminating the box. Our ratio analysis further revealed that infants in the same-language condition were more likely to interact with the box using their heads than their hands when compared to the infants in the foreign-language condition. This finding constitutes further evidence indicating that infants were not only inclined to selectively learn from the speakers of their own language, but they were also more likely to preserve the sub-efficient action manner that the same language demonstrator presented to them despite being able to operate the lamp more efficiently with their hands (see Altınok, Hernik, Király, & Gergely, 2020; Krieger, Aschersleben, Sommerfeld, & Buttelmann, 2020, for a similar pattern of findings with preschoolers).

Our study also introduced an important additional control, the no-demonstration condition. The number of infants performing a head-touch was similar when comparing the foreign-language with the no-demonstration condition, suggesting that the infants in the foreign-language condition had not considered epistemically relevant to imitate and acquire the opaque head-touch action that the foreign language speaking adult informant ostensively demonstrated to them. Moreover, our ratio analysis also confirmed that infants in the foreign-language speaker condition did not interact with the lightbox differently than the infants in the no-demonstration condition. Infants in both conditions mostly acted on the box with their hands rather than with their heads. This was in stark contrast with infants in the same-language speaker condition. Given the similar pattern of findings in the foreign-language speaker and no-demonstration conditions, one could suggest that infants in the foreign-language speaker condition did not learn anything from a foreign language speaking demonstrator. However, while the rate at which infants successfully brought about the light effect was high for the infants in the same- and foreign-language speaker conditions (94% and 81%, respectively) infants in the no-demonstration condition were not very successful in lighting up the novel touch-lamp (50%). This alone suggests that the action demonstration itself had a facilitatory effect in enabling infants to learn about object functions – the lamp could be lit – irrespective of the language of the demonstrator.

It is important to note that Howard et al. (2015) could not find selective imitation in 19-month-olds of the sub-efficient actions manifested to them in a live demonstration by an informant speaking the same language as the infants' own social group. Critically, in their first experiment, which employed a between subject design and the novel use of the target artifact was presented to the two groups of infants by either the same- or foreign-language speaking demonstrator, there was another experimenter present during the response phase who always spoke the same language as the infants' own social group encouraging them to act on the target apparatus (with the verbal prompt, "What does this do?") in both conditions.

The presence of another same-language speaking adult, despite not being the demonstrator, could be the reason why infants in this particular experiment imitated the foreign-language speaker at similar rates as they did when the earlier demonstrator was a same-language speaking informant. As covered by previous research (Király, 2009; Kupán et al., 2017; Nielsen & Blank, 2011; Over & Carpenter, 2012), the presence of an adult experimenter influences imitative behaviors of infants and children. Despite speaking a foreign language, the ostensive cues that the demonstrator exploited (e.g., making eye contact, using infant-directed intonation in speech) might have played a significant role in influencing the 19-month-olds' performance in Howard et al.'s experiment by leading them to align their imitative reenactment with the modeled behavior especially when there was an external pressure to do so due to the presence of another adult during the reenactment phase. Infants may have been motivated to show that they could indeed act on the target objects in the same manner as was ostensively shown to them by the foreign-language speaker earlier when they were explicitly encouraged to act on the objects by another person. Importantly in our experiment there was no experimenter present in the response phase (as it was the case in the original study of Buttelmann et al., 2013, as well), and the participants were not given any verbal instruction.

More critically, the live mode of presentation does not seem to be a deterministic factor making it difficult for infants to show selectivity in their imitation behaviors as argued by Howard et al. (2015). Infants in our experiment were able to selectively acquire and reenact cognitively opaque means actions when it was demonstrated by a same-language speaking model but not when demonstrated by an equally ostensive model who spoke a foreign language. Clearly, infants were not simply driven by a motivation to imitate the opaque means actions demonstrated to them just because the demonstrators addressed them communicatively in a live context. Here in a very minimal set-up, with no external social pressure to act on the target apparatus, we found no evidence that would indicate that infants at this age find it difficult to inhibit imitating what they were communicatively demonstrated within a live context. Rather the presence of an adult experimenter in the response phase and the verbal prompt that emphasized the function of the target item (i.e., "What does this do?") might have had a more robust influence on infants' reenactment of the demonstrated novel actions in the experiment by Howard et al. (2015) which have resulted in a lack of selectivity in their imitative behaviors.

Another important factor that might contribute to the question of when and why infants could show readiness to learn from communicative informants who speak a foreign language could be infants' previous exposure and experience with multiple languages spoken in their social environment. Indeed, Howard and her colleagues documented that infants who live in linguistically diverse neighborhoods were less likely to be selective in their imitation as a function of the language spoken by the demonstrators, despite themselves being monolingual (Howard, Carrazza, & Woodward, 2014). This effect was not merely driven by infants' exposure to the particular foreign language the demonstrator was speaking in the experiment but was rather related with infants' general experience with different non-native languages being often spoken in their social environment. From this angle it remains a possibility that our study replicated the selective imitation findings of Buttelmann et al.'s (2013) experiment in a live context not only due to the procedural similarity but

potentially also because both cities from which the infants were recruited from in the two studies were less linguistically diverse than the metropolitan areas where the experiments of Howard et al. (2014, 2015) were conducted.

To sum up, our results document that ostensive demonstration by a same-language speaking model enabled 18-month-old infants to acquire the opaque manner in which the goal was achieved as revealed by the higher rates of high-fidelity imitation in the same-language condition in contrast to the foreign-language condition. Learning sub-efficient action manners selectively from same-language speaking informants and spontaneously performing them even in the absence of the informants – despite being able to bring about the desired goal in a more efficient way as well – suggests that humans evaluate the cultural relevance of the demonstrated information based on whether the demonstrator is a speaker of the same language that is used in the infant's social community, a factor that selectively induces them to reenact and learn the demonstrated action skills that they deem culturally relevant. These findings are also in line with previous studies that document selective learning as a function of the demonstrators' social group membership with preschool aged children in minimal group paradigms. For example, a recent study (Li, Liao, Cheng, & He, 2019) found that 6-year-olds were more likely to behaviorally match their responses to their ingroup members at the expense of efficacy. Gruber and his colleagues (Gruber, Deschenaux, Frick, & Clément, 2019) also documented the role of social group membership in 4- and 5-year-old children's selective imitation of the sub-efficient action routines manifested by demonstrators belonging to their own minimal group over a minimal outgroup (but with mixed results with respect to sex). As it turns out, even when their minimal ingroup member is antisocial (i.e., portrayed as either causing intentional harm or as being selfish) preschool aged children are still selective in their imitation (Wilks, Kirby, & Nielsen, 2018): they preferentially copy the sub-efficient means actions demonstrated by the antisocial ingroup over the prosocial outgroup despite indicating greater liking of the outgroup demonstrator.

While our study demonstrates that already before their second year of life children's selective imitation is driven by a motivation to acquire culturally relevant knowledge from informants belonging to their own linguistic social group, it remains an exciting avenue for future research to explore how exactly same-language vs foreign-language spoken prior to a demonstration leads to differential encoding of the same content as our findings cannot be explained simply in terms of differential amount of overt attention allocated to the different models. For now, we suggest that same-language spoken by the model might help infants to encode a novel arbitrary mean action as a relevant cultural sub-goal given its sub-efficiency in relation to the end-state. Despite having a small sample size, this study provides additional evidence for cultural learning taking place early in ontogeny and proposes that the unique human tendency of acquiring opaque sub-efficient means actions from members of the social and cultural group in which they are brought up has evolved to support the transmission of normative cultural knowledge shared within one's social group.

Acknowledgments

We thank Ágnes Volein, Dóri Mészégető, Iulia Savoş, Maria Toth, and Zsuzsanna Karap for their help with recruitment, data collection and coding. We also thank all the infants who took part in this research and their parents. The authors declare no conflict of interests.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability

The data that support the findings of this study are openly available at the Open Science Framework at https://doi.org/10.17605/OSF.IO/FTKBM

Open scholarship

This article has earned the Center for Open Science badge for Open Data. The data are openly accessible at https://doi.org/10.17605/OSF.IO/FTKBM.

Funding

This research was supported by the European Research Council (ERC) under the European Union's Seventh Framework Programme (FP7/10254, 2015-2021)/ERC Grant 609819.

ORCID

Nazlı Altınok http://orcid.org/0000-0003-1155-4415
Ildikó Király http://orcid.org/0000-0002-4857-1764

References

Altınok, N., Hernik, M., Király, I., & Gergely, G. (2020). Acquiring sub-efficient and efficient variants of novel means by integrating information from multiple social models in preschoolers. *Journal of Experimental Child Psychology*, *195*, 104847. doi:10.1016/j.jecp.2020.104847

Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *American Behavioral Scientist*, *48*(5), 505–522. https://doi.org/10.17605/OSF.IO/FTKBM

Begus, K., Gliga, T., & Southgate, V. (2016). Infants' preferences for native speakers are associated with an expectation of information. *Proceedings of the National Academy of Sciences*, *113*(44), 12397–12402. doi:10.1073/pnas.1603261113

Birch, S. A., Akmal, N., & Frampton, K. L. (2010). Two-year-olds are vigilant of others' non- verbal cues to credibility. *Developmental Science*, *13*(2), 363–369. doi:10.1111/j.1467-7687.2009.00906.x

Brooker, I., & Poulin-Dubois, D. (2013). Is a bird an apple? The effect of speaker labeling accuracy on infants' word learning, imitation, and helping behaviors. *Infancy*, *18*, E46- E68. doi:10.1111/infa.12027

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the right thing: Infants' selection of actions to imitate from observed event sequences. *Child Development*, *78*(3), 806–824. doi:10.1111/j.1467-8624.2007.01034.x

Buchsbaum, D., Gopnik, A., Griffiths, T. L., & Shafto, P. (2011). Children's imitation of causal action sequences is influenced by statistical and pedagogical evidence. *Cognition*, *120*(3), 331–340. doi:10.1016/j.cognition.2010.12.001

Buttelmann, D., Zmyj, N., Daum, M., & Carpenter, M. (2013). Selective imitation of in-group over out-group members in 14-month-old infants. *Child Development*, *84*(2), 422–428. doi:10.1111/j.1467-8624.2012.01860.x

Csibra, G., & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. In Y. Munakata & M. H. Johnson (Eds.), *Processes of change in brain and cognitive development (Attention and performance)* (Vol. 21, pp. 249–274). Oxford: Oxford University Press.

Csibra, G. (2010). Recognizing communicative intentions in infancy. *Mind & Language*, *25*(2), 141–168. doi:10.1111/j.1468-0017.2009.01384.x

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences*, *13*(4), 148–153. doi:10.1016/j.tics.2009.01.005

Futó, J., Téglás, E., Csibra, G., & Gergely, G. (2010). Communicative function demonstration induces kind-based artifact representation in preverbal infants. *Cognition*, *117*(1), 1–8. doi:10.1016/j.cognition.2010.06.003

Gellén, K., & Buttelmann, D. (2019). Rational imitation declines within the second year of life: Changes in the function of imitation. *Journal of Experimental Child Psychology*, *185*, 148–163. doi:10.1016/j.jecp.2019.04.019

Gergely, G., & Csibra, G. (2006). Sylvia's recipe: The role of imitation and pedagogy in the transmission of cultural knowledge. In N. J. Enfield & S. C. Levinson (Eds.), *Roots of human sociality: Culture, cognition, and human interaction* (pp. 229–255). Oxford, UK: Berg Press.

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, *415* (6873), 755. doi:10.1038/415755a

Gergely, G., Egyed, K., & Király, I. (2007). On pedagogy. *Developmental Science*, *10*(1), 139–146. doi:10.1111/j.1467-7687.2007.00576.x

Gruber, T., Deschenaux, A., Frick, A., & Clément, F. (2019). Group membership influences more social identification than social learning or overimitation in children. *Child Development*, *90*(3), 728–745. doi:10.1111/cdev.12931

Hernik, M., & Csibra, G. (2015). Infants learn enduring functions of novel tools from action demonstrations. *Journal of Experimental Child Psychology*, *130*, 176–192. doi:10.1016/j.jecp.2014.10.004

Howard, L. H., Carrazza, C., & Woodward, A. L. (2014). Neighborhood linguistic diversity predicts infants' social learning. *Cognition*, *133*(2), 474–479. doi:10.1016/j.cognition.2014.08.002

Howard, L. H., Henderson, A. M., Carrazza, C., & Woodward, A. L. (2015). Infants' and young children's imitation of linguistic in-group and out-group informants. *Child Development*, *86*(1), 259–275. doi:10.1111/cdev.12299

Kinzler, K. D., Dupoux, E., & Spelke, E. S. (2007). The native language of social cognition. *Proceedings of the National Academy of Sciences*, *104*(30), 12577–12580. doi:10.1073/pnas.0705345104

Kinzler, K. D., & Liberman, Z. (2017). Infants' inferences about language are social. *Proceedings of the National Academy of Sciences*, *114*(19), E3753–E3754. doi:10.1073/pnas.1701553114

Király, I. (2009). The effect of the model's presence and of negative evidence on infants' selective imitation. *Journal of Experimental Child Psychology*, *102*(1), 14–25. doi:10.1016/j.jecp.2008.06.003

Király, I., Csibra, G., & Gergely, G. (2013). Beyond rational imitation: Learning arbitrary means actions from communicative demonstrations. *Journal of Experimental Child Psychology*, *116*(2), 471–486. doi:10.1016/j.jecp.2012.12.003

Kovacs, A. M., Téglás, E., Gergely, G., & Csibra, G. (2017). Seeing behind the surface: Communicative demonstration boosts category disambiguation in 12-month- olds. *Developmental Science*, *20*(6), e12485. doi:10.1111/desc.12485

Krieger, A. A., Aschersleben, G., Sommerfeld, L., & Buttelmann, D. (2020). A model's natural group membership affects over-imitation in 6-year-olds. *Journal of Experimental Child Psychology*, *192*, 104783. doi:10.1016/j.jecp.2019.104783

Kupán, K., Király, I., Kupán, K., Krekó, K., Miklósi, Á., & Topál, J. (2017). Interacting effect of two social factors on 18-month-old infants' imitative behavior: Communicative cues and demonstrator presence. *Journal of Experimental Child Psychology*, *161*, 186–194. doi:10.1016/j.jecp.2017.03.019

Li, Y., Liao, Y., Cheng, Y., & He, J. (2019). Group conquers efficacy: Preschoolers' imitation under conflict between minimal group membership and behavior efficacy. *PLoS One*, *14*(9), e0223101. doi:10.1371/journal.pone.0223101

Marno, H., Guellai, B., Vidal, Y., Franzoi, J., Nespor, M., & Mehler, J. (2016). Infants' selectively pay attention to the information they receive from a native speaker of their language. *Frontiers in Psychology*, *7*, 1150. doi:10.3389/fpsyg.2016.01150

Meltzoff, A. N. (1988). Infant imitation and memory: Nine-month-olds in immediate and deferred tests. *Child Development*, *59*(1), 217–225. doi:10.2307/1130404

Nielsen, M., & Blank, C. (2011). Imitation in young children: When who gets copied is more important than what gets copied. *Developmental Psychology*, *47*(4), 1050–1053. doi:10.1037/a0023866

Over, H., & Carpenter, M. (2012). Putting the social into social learning: Explaining both selectivity and fidelity in children's copying behavior. *Journal of Comparative Psychology*, *126*(2), 182–192. doi:10.1037/a0024555

Poulin-Dubois, D., Brooker, I., & Polonia, A. (2011). Infants prefer to imitate a reliable person. *Infant Behavior and Development*, *34*(2), 303–309. doi:10.1016/j.infbeh.2011.01.006

Shutts, K., Kinzler, K. D., McKee, C. B., & Spelke, E. S. (2009). Social information guides infants' selection of foods. *Journal of Cognition and Development*, *10*(1–2), 1–17. doi:10.1080/15248370902966636

Soley, G., & Sebastián-Gallés, N. (2015). Infants prefer tunes previously introduced by speakers of their native language. *Child Development*, *86*(6), 1685–1692. doi:10.1111/cdev.12408

Sperber, D., Clément, F., Heintz, C., Mascaro, O., Mercier, H., Origgi, G., & Wilson, D. (2010). Epistemic vigilance. *Mind & Language*, *25*(4), 359–393. doi:10.1111/j.1468-0017.2010.01394.x

Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition*. Oxford, UK: Blackwell.

Wilks, M., Kirby, J., & Nielsen, M. (2018). Children imitate antisocial in-group members. *Developmental Science*, *21*(6), e12675. doi:10.1111/desc.12675

Zmyj, N., Buttelmann, D., Carpenter, M., & Daum, M. M. (2010). The reliability of a model influences 14-month-olds' imitation. *Journal of Experimental Child Psychology*, *106*(4), 208–220. doi:10.1016/j.jecp.2010.03.002