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PAPER

Child-directed teaching and social learning at 18 months of age: evidence from Yucatec Mayan and US infants

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Abstract

In several previous studies, 18-month-old infants who were directly addressed demonstrated more robust imitative behaviors than infants who simply observed another's actions, leading theorists to suggest that child-directed interactions carried unique informational value. However, these data came exclusively from cultural communities where direct teaching is commonplace, raising the possibility that the findings reflect regularities in infants' social experiences rather than responses to innate or a priori learning mechanisms. The current studies consider infants' imitative learning from child-directed teaching and observed interaction in two cultural communities, a Yucatec Mayan village where infants have been described as experiencing relatively limited direct instruction (Study 1) and a US city where infants are regularly directly engaged (Study 2). Eighteen-month-old infants from each community participated in a within-subjects study design where they were directly taught to use novel objects on one day and observed actors using different objects on another day. Mayan infants showed relative increases in imitative behaviors on their second visit to the lab as compared to their first visit, but there was no effect of condition. US infants showed no difference in imitative behavior in the child-directed vs. observed conditions; however, infants who were directly addressed on their first visit showed significantly higher overall imitation rates than infants who observed on their first visit. Together, these findings call into question the idea that child-directed teaching holds automatic or universal informational value.

Research highlights

- This is the first study to consider how child-directed teaching relates to imitative learning in a cultural community (Yucatec Mayan) where pedagogical teaching is infrequent in infancy.
- Yucatec Mayan (Study 1) and US (Study 2) infants were directly taught novel actions on objects on one visit, and observed actors performing actions with objects on a second visit.
- Mayan infants showed relative increases in imitative behaviors on their second visit to the lab as compared to their first visit, but there was no effect of condition. US infants who were directly taught on their first visit showed higher rates of imitation than children who observed on their first visit, even on the second day of testing.
- These results suggest that the value of child-directed teaching likely depends on infants' reasoning regarding the relevance that communicated information has for them; this reasoning may vary based on infants' early social experiences.

Introduction

Imitation is a powerful tool for supporting the transmission of cultural information. By faithfully copying the actions of others, infants and young children are able to quickly acquire complex knowledge regarding the function and use of cultural artifacts, information that would be difficult or impossible to attain through infants' exploration alone.

While infants are proficient imitators, recent research suggests that not all social situations are equally informative for fostering imitative behaviors for infants living in communities where directed teaching is commonplace. In several studies 11- to 18-month-old infants were more

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likely to faithfully copy others' actions when they were directly taught the action (e.g. when the actor looked at and talked to the infant), as compared to when they simply observed these actions (Brugger, Lariviere, Mumme & Bushnell, 2007; Király, Csibra & Gergely, 2013; Matheson, Moore & Akhtar, 2013; Nielsen, 2006; Sage & Baldwin, 2011; Shneidman, Todd & Woodward, 2014). For example, at 18 months, infants were more likely to imitate the particular means of a demonstrated novel action (like using the head to turn on a light, or an elbow to activate a switch) when an experimenter looked and talked to the infant while performing the action, as compared to when she talked to herself (Matheson *et al.*, 2013) or to another person (Shneidman *et al.*, 2014). Differential imitation following child-directed and observed events occurred even when infants deployed equal visual attention to these contexts, suggesting that child-directed situations provide informational value beyond the ways in which they shape infants' attention in the moment (Sage & Baldwin, 2011; Shneidman *et al.*, 2014).

These findings have led social learning theorists to conclude that child-directed interactions critically support early learning (e.g. Csibra & Gergely, 2006, 2009, 2011; Akhtar & Tomasello, 1998; Barresi & Moore, 1996; Herold & Akhtar, 2008; Moll & Tomasello, 2007; Moore, 2010; Tomasello, 1995, 1999). Indeed, two theoretical stances propose that child-directed interactions are the foundation for this learning (see review in Shneidman & Woodward, 2015). One position is that, when directly engaged, infants gain a conceptual understanding of another's intentions because they share attentional focus and social goals with a partner (e.g. Akhtar & Tomasello, 1998; Barresi & Moore, 1996; Herold & Akhtar, 2008; Moll & Tomasello, 2007; Moore, 2010; Tomasello, 1995, 1999). This account assumes that infants will learn more robustly from child-directed, as compared to observed, interactions until they develop cognitive capacities such as perspective taking that allow them to understand others' intentions in the absence of mutual focus (e.g. Moore, 2010). A second theoretical position (e.g. Csibra & Gergely, 2006, 2009, 2011) places little importance on the mutual engagement that occurs during episodes of child-directed interaction. Instead, it is thought that the ostensive signals that occur during child-directed interaction trigger an innate modular learning system in the infant, whereby the infant assumes that presented information is culturally relevant and generalizable to other exemplars (e.g. Csibra & Gergely, 2006, 2009, 2011).

While these two social learning accounts differ from each other in many ways, both assume that child-directed input provides unique value that is not dependent on the child's learning about this value. In the case of the first account, child-directed interactions are claimed to be inherently informative because of their shared intentional structure. In the case of the second account, child-directed contexts are argued to automatically increase sensitivity to generalizable information. Thus, both accounts predict child-directed interactions to be broadly and universally informative for supporting infants' early cultural learning.

However, because data linking child-directed contexts to heightened imitative learning come exclusively from industrialized Western communities where instructional interaction with infants is commonplace, it is unknown whether infants' increased proclivity to imitate following child-directed interaction is a universal constant, or simply corresponds to the typical experiences some infants have. Infants' increased tendency to imitate following child-directed cuing (e.g. interactions where a caregiver looks at and talks to the infant) may reflect learning strategies that have been developed via frequent participation in child-directed interaction. Moreover, child-directed interactions often require a response from infants, and infants may learn to respond in these situations as part of a familiar routine (i.e. you do that, I do this).

The extent to which children are engaged in instructional interaction with adults likely shows wide cross-cultural variation. In many places in the world infants are described as being only rarely directly addressed by caregivers in pedagogical teaching contexts (e.g. de Leon, 1998; Gaskins, 1999, 2006; Gaskins & Paradise, 2010; Lieven, 1994; Ochs & Schieffelin, 1994; Pye, 1986; Rogoff, 2003; Rogoff, Mistry, Göncü & Mosier, 1993), and infants and children are encouraged and expected to learn from observing the actions of others (e.g. Rogoff *et al.*, 1993; Gaskins & Paradise, 2010). Indeed, school-aged children growing up in a Guatemalan Mayan community, where observational learning is valued, are more likely to attend to and learn a new skill from observation than same-aged peers in the United States (Correa-Chávez & Rogoff, 2009). These findings suggest that children's cultural experiences can shape the way they effectively learn from others, and raise the possibility that infants may also show culturally specified learning. Thus, instead of being an a priori cue that always facilitates learning in infancy, child-directed contexts could come to have meaning based on infants' early social experiences. Infants growing up in communities where child-directed teaching is commonplace could learn that information marked with direct cues is particularly important, informative, or worth responding to. In contrast, infants growing up in places where these interactions are less common and less likely to be

culturally valued could employ different strategies that rely more broadly on the observation of others' actions.

In Study 1, we test this possibility by exploring the role child-directed communication has for informing imitative learning for 18-month-old infants from a Yucatec Mayan community. Mayan caregivers generally, and Yucatec Mayan caregivers more specifically, have been described as rarely directly addressing infants in pedagogical contexts, following-in on infants' attentional focus, or engaging them in child-directed object play (e.g. de Leon, 1998; Gaskins, 1999, 2006; Pye, 1986; Rogoff, 2003). Instead, infants receive ample experience observing the actions of others (e.g. Gaskins, 1999; Gaskins & Paradise, 2010; Shneidman & Goldin-Meadow, 2012). This is due to several factors. First, Mayan families are typically large (e.g. de Leon, 1998; Gaskins, 2006; Rogoff, 2003; Shneidman & Goldin-Meadow, 2012), making it likely that Mayan children spend most of their waking hours with multiple others. Second, Mayan children are growing up in an environment where learning from observation has high cultural value, whereas child-directed teaching does not. Mayan caregivers regard early development as a process that unfolds naturally, requiring little active intervention on the part of caregivers (e.g. Gaskins, 1999), and parents have a theory of learning that gives agency to children's seeking of information in shared, non-instructional social contexts (e.g. Gaskins & Paradise, 2010). In addition, caregivers typically have relatively limited experience in formal schooling contexts (e.g. Rogoff, 2003), a factor that is of importance because formal schooling enforces a learning model where children are directly taught and then rewarded for expressing what they were taught. Indeed, previous research has shown that caregivers with limited experience with formal schooling have children that are more likely to attend to and learn from observed interactions than children of caregivers with more schooling experience (Correa-Chávez & Rogoff, 2009).

Together these factors make it likely that Mayan children spend less time in one-on-one, child-directed teaching interactions, and likely spend more time observing the social interactions of other people. Indeed, prior research has found that 18-month-old infants growing up in the villages where Study 1 was conducted hear nearly 60% of their total language input, from both adults and children, in overheard and not child-directed speech, as compared to 30% for infants from large families in the United States (Shneidman & Goldin-Meadow, 2012). Infants in this community have many opportunities to observe others' conversations, but, at least early on, they are rarely directly addressed.

Given these properties of infants' early social experiences, in Study 1 we consider whether Yucatec Mayan infants display the same pattern of responses to child-directed and observed contexts as infants from the United States have demonstrated in prior studies (e.g. Brugger *et al*., 2007; Király *et al*., 2013; Matheson *et al*., 2013; Nielsen, 2006; Sage & Baldwin, 2011; Shneidman *et al*., 2014). Using a nearly identical procedure as Shneidman *et al*. (2014), we ask if Mayan infants, like US infants, demonstrate more robust imitative behavior when directly addressed as compared to when observing an interaction. If, as has been suggested, there is something special about child-directed interactions for informing infants' conceptual understanding of an actor's intentions, or for triggering a learning stance to treat information as generalizable, then one would expect child-directed communication to be important for supporting imitative learning even in this community where child-directed interactions are a relatively uncommon form of early social experience.

Study 1

Method

Participants

Twenty Yucatec Mayan infants (12 females, 8 males) from three nearby villages (population of around 600 each) on the Yucatan peninsula participated (Mean age: 18.0; Range: 15.3–21.2 months). Infants were age-matched (within a two-week period) across four counterbalanced orders based on condition order and toy set order. Participants were recruited by the first author or via word of mouth. Two additional infants participated in the experimental procedure but were excluded from the final sample due to distress. The subjects matched the demographic characteristics that have been previously described for this population (e.g. Shneidman & Goldin-Meadow, 2012). Subjects came from large families and had on average 2.5 siblings (SD = 2.2, Range = 0–9 siblings). Subjects' mothers had relatively limited experience in formal schooling contexts. On average they had attended school for 5 years (SD = 3.0, Range = 0–9 years).

Materials

Test items consisted of two sets of six novel objects designed to have one functional action demonstrated in a causally opaque manner (Set A and Set B). Items in set A were: (1) a toy horse with a hidden button in the tail, activated by pressing the horse on the demonstrator's upper arm, (2) a plastic dolphin with a hidden magnet in

the nose, that was bounced up and down before making a mark on a magnetic slate, (3) a set of cups that were banged together several times then connected to form a ball, (4) a tower in which a ball was pushed down a hole using a plastic ring, (5) a box with a push button lid that was opened with the demonstrator's chin, and (6) a stuffed dog that moved when pressed with the back of the demonstrator's hand. Items in set B were: (1) a cardboard house where a doll was pressed on a patch to activate a sound, (2) a box that made a noise when a plastic tool was pressed on a button, (3) a ring that was brought to the demonstrator's eye before being placed on a wooden peg, (4) a box that was opened with a tab after a block was first knocked against it, (5) a light that was activated by the demonstrator pressing her head on it, and (6) a toy monkey that made a squeaking noise when the demonstrator pressed her elbow on it.

Procedure

Infants from the three adjacent villages, with their caregiver, were driven to a central village (if they did not live there) and tested in a single-room house rented by the first author for visits on two consecutive days. Infants in the *Child-directed-first* order were assigned to the child-directed condition on their first visit, and the observed condition on their second visit, while infants in the *Observed first* visit order were assigned to the observed condition on their first visit and the child-directed condition on their second visit. The toy set seen by the infants on their first visit (Set A or Set B) was counterbalanced across infants and crossed with visit order. Infants saw the remaining toy set on their second visit. The experimenters (host and demonstrator) were native Yucatec Mayan speakers and members of this central village. Four of the study participants were also from the central village, and thus may have had prior familiarity with the experimenters (but were not immediate family members of either experimenter). These four infants were equally distributed across the four counterbalanced condition orders. Infants saw the same two experimenters on each visit day.

During each of the visits the child sat in front of a large table next to their parent, or on their parent's lap. A second smaller table was positioned approximately 7 feet away from where the child was sitting and within his or her visual range. The procedure during each visit consisted of two sets of baseline, demonstration, and test phases. (See Figure 1.)

Baseline phase. During each baseline phase, an experimenter (the host) presented the child, sequentially, with three of the test items (in fixed order). The child had the opportunity to explore each object for 30 seconds or until he or she disengaged from the item. Following this, the host left the room and then re-entered the room with a second experimenter (the demonstrator).

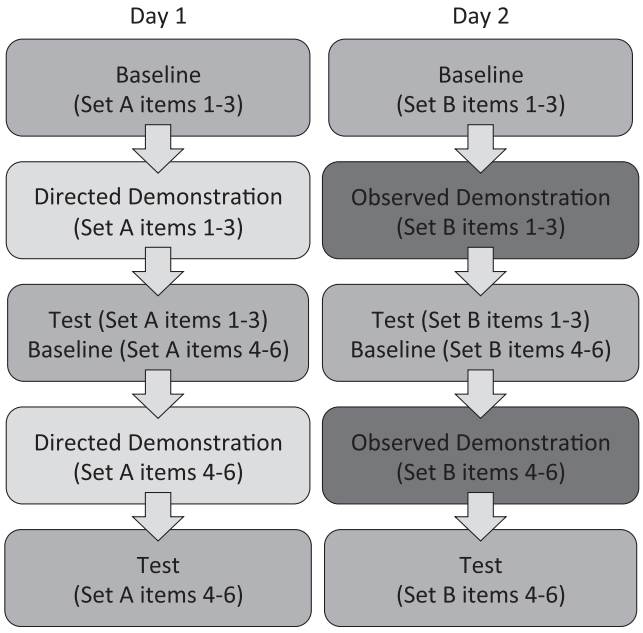

Figure 1 *Study design for Studies 1 and 2. Order of visits (child-directed or observed first) and order of toy set (Set A or Set B first) counterbalanced across children.*

Demonstration phase. In the *child-directed condition*, both the host and the demonstrator stood behind the small table, approximately 7 feet away from the infant. They each made direct eye contact with the child and each experimenter directed their utterances to the child (in Yucatec Mayan). The demonstrator picked up each of the (first three) objects in sequence, placed the objects on the small table, and, while making eye contact with the child, demonstrated how to use the object twice while saying, 'Let's see what this thing does.'and "Let's see that again." The host responded "neat!" and "wow!" following each demonstration while looking at the child. The *observed condition* was the same as the child-directed condition, except instead of addressing the child, the demonstrator and the host only spoke to one another, and never made direct eye contact with the child. Following this, both experimenters left the room, and the host returned immediately to begin the test phase.

Test phase. During the test phase, the host once again presented each of the three objects to the child. The child was allowed to interact with each object for 30 seconds, or until they became bored with the toy. Following this,

the host initiated the second baseline phase with the remaining three test objects, and the entire phase sequence was repeated.

Scoring

Infants were given a score corresponding to the proportion of objects imitated in the manner demonstrated (e.g. using their head to activate the light) at baseline and at test in each condition by a research assistant blind to condition and hypothesis. Infants were given credit for performing the manner imitation whether or not their actions were effective (e.g. they used their head on the light switch but failed to activate the light). A second independent assistant coded a randomly selected 25% of the participants, with the coders agreeing on 92% of the total behavioral scores. Parental interference occurred during one test trial for five infants. This trial was dropped from the analysis for these children, and children received a score based on the remaining items.

Results and discussion

Preliminary analyses revealed no significant effects or interactions of child gender on imitation scores so subsequent analyses collapsed across male and female participants. Infants performed significantly more actions during the test phase than during the baseline in both the child-directed (Baseline: $M(SD)$ = .03(.06), Test: $M(SD)$ = .23(.20), $t[19] = 4.1$, $p = .001$), and observed (Baseline $M = .01$, $SD = .04$; Test $M = .23$, $SD = .20$; $t[19] = 4.7$, $p < .001$) conditions, indicating that they learned the novel actions in both conditions. In order to assess learning (and to not give credit for actions infants performed prior to training), subsequent analyses assessed infants' performance by considering the proportion of objects imitated at test minus their a priori performance of the demonstrated actions on baseline trials (test minus baseline). For example if an infant performed three of the six actions at test, and one of the six actions at baseline, that infant would receive a score of .33 ([3 − 1]/6).

While infants showed significant learning from baseline to test for both the objects in Set A ($t[19] = 3.6$, $p = .002$) and the objects in Set B ($t[19] = 5.3$, $p < .001$), infants imitated a higher proportion of actions with the objects in Set B ($M = .26$, $SD = .21$) than the objects in Set A ($M = .16$, $SD = .20$, $F[1, 16] = 14.91$, $p = .001$). This did not vary depending on the visit order infants were assigned to (child-directed first vs. observed first) but did vary depending on what toy set (Set A or Set B) infants received on their first visit, $F(1, 16) = 15.91$ $p = .001$. Namely, infants who received Set A objects on their first visit, imitated more actions with Set B than Set A, $t(9) = 4.91$ $p = .001$, while infants who received Set B objects on their first visit showed no difference in imitation rates between the toy sets, $t(9) = .11$, $p = .91$.

In order to assess infants' imitation across conditions a repeated measures ANOVA with condition (child-directed or observed) as a within-subjects measure and visit order (child-directed first visit or observed first visit) and toy set order (Set A first or Set B first) as between-subjects measures was conducted on infants' imitation score (test minus baseline score), with child age as a covariate. Results revealed a main effect of age, $F(1, 16) = 18.7$, $p = .001$, indicating that older infants showed more robust imitation than younger infants, but this did not vary by condition. There was no main effect of condition (child-directed vs. observed), $F(1, 16) = .02$, $p = .89$, of visit order (child-directed first visit vs. observed first visit), $F(1,16) = .13$, $p = .72$, or of toy set order, $F(1,16) = .31$, $p = .58$, and no interaction between toy set order and condition, $F(1,16) = .081$, $p = .78$. There was, however, a significant interaction between condition and visit order, $F(1,16) = 8.27$, $p = .01$. This interaction indicates that the effect of condition differed depending on order; infants in the child-directed first order were relatively more likely to imitate at the observed (second) visit as compared to the child-directed (first) visit, while infants in the observed first visit order showed the opposite pattern of results and were relatively more likely to imitate in the directed (second) visit as compared to the observed (first) visit. Put another way, across orders, infants showed relative increases in imitative behaviors on their second visit to the lab as compared to their first visit. Indeed, a repeated measures ANOVA with visit day (day 1 or day 2) as a within-subjects measure and visit order (child-directed first or observed first) as a between-subjects measure revealed a main effect of visit order, $F(1, 18) = 9.26$, $p = .007$, indicating greater imitation on day 2 as compared to day 1. (See Figure 2.)

Thus, Mayan infants displayed a very different pattern of results from the US infants described in previous studies (e.g. Brugger *et al.*, 2007; Király *et al.*, 2013; Matheson *et al.*, 2013; Nielsen, 2006; Sage & Baldwin, 2011; Shneidman *et al.*, 2014). Infants seemed to be learning generally about the lab setting, perhaps by becoming more comfortable with the room or with the experimenters, or gaining experience manipulating stimuli, and thus performed more imitative actions on their second visit than on their first visit; however, child-directedness was not a relevant cue for informing this imitation. The Mayan infants showed no differences in imitation rates across the child-directed and the observational conditions.

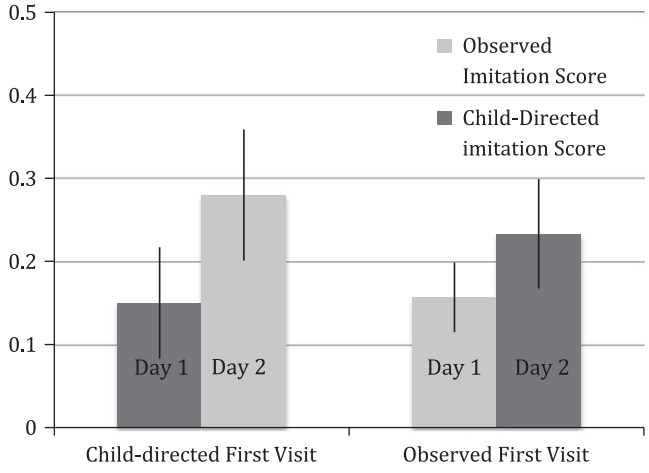

Figure 2 *Proportion of manner-actions imitated (test minus baseline) in the Observed and Child-directed conditions for Yucatec Mayan children in the Child-directed first and the Observed first visit orders.*

Study 2

Study 1 demonstrated that Mayan infants' imitative rates do not depend on whether or not they were directly engaged. In contrast, prior research with infants growing up in communities where child-directed interaction is commonplace (e.g. Brugger *et al.*, 2007; Király *et al.*, 2013; Matheson *et al.*, 2013; Nielsen, 2006; Sage & Baldwin, 2011; Shneidman *et al.*, 2014) suggests that direct cuing is an important factor for informing imitation. While Study 1 utilized an experimental paradigm almost identical to one of these prior studies (Shneidman *et al.*, 2014), there was one potentially important difference in the experimental paradigms. Namely, Study 1 was a within-subjects design (because of the small number of potential subjects in the Mayan villages), whereas prior work demonstrating differences in imitation rates has relied on a between-subjects design (where infants are assigned to either a child-directed or observational condition). Thus, in Study 2 we assessed US infants' responses to child-directed and observed actors using the same procedure as Study 1, in order to provide a closer point of comparison. We asked whether US children's responses in the within-subjects imitation paradigm follow the same pattern of results as previously reported findings from between-subjects paradigms (e.g. infants display enhanced imitative behaviors following child-directed as compared to observational contexts).

Method

Participants

Twenty infants (12 females, 8 males) from mostly professional families in the greater Chicago area participated (Mean age: 17.9 months; Age range: 15.5 –21.2 months). Participants were recruited from a database of families managed by a university. The age (within a two-week period) and the sex of each child were matched to correspond to participants from the Yucatec Mayan community described in Study 1 and age matched across the four counterbalanced orders as described in Study 1. Five additional infants participated in the experimental procedure but were excluded from the final sample due to parental interference on more than two test trials (1), distress (2), or experimental error (2). The sample of infants was 50% European or White-American, 20% African or African-American, 20% multiracial and 10% Hispanic or Latino-American. As expected, US infants differed from the Mayan infants in several ways that are consistent with the reported cultural differences between the two communities and are likely to relate to variation in experience in child-directed, pedagogical contexts. US infants typically had fewer siblings (M (SD) = .20(.52); Range = 0–2 siblings) than the Mayan infants described in Study 1, $t(38) = -4.7$, $p < .001$, and mothers of US infants had more years of formal schooling ($M(SD)$ = 17.8(2.8); Range = 14–20 years), as compared to the Mayan mothers described in Study 1, $t(38) = 14.0$, $p < .001$.

Materials, procedure and scoring

The materials, procedure and scoring for Study 2 were identical to that described in Study 1 except that the experimenters spoke in English instead of Yucatec Maya and participants were tested in a laboratory room at an urban university (which they travelled to by car, public transportation, or on foot), instead of in a village hut. A second independent assistant coded 25% of the participants, with the coders agreeing on 95% of the total behavioral scores.

Results

Preliminary analyses revealed no significant effects or interactions of child gender on imitation scores so subsequent analyses collapsed across male and female participants. Infants performed significantly more actions during the test phase than during the baseline phase in both the child-directed (Baseline: $M(SD)$ = .06(.08), Test: $M(SD)$ = .36(.30), $t[19] = 4.5$, $p < .001$) and observed(Baseline: $M(SD)$ = .08(.13), Test: $M(SD)$ = .38(.22), $t[19] = 6.2$, $p < .001$) conditions, indicating that infants learned novel actions in both conditions. Subsequent analyses considered infants' performance by considering their imitation

score on test trials minus baseline trials (test minus baseline). Like Mayan infants, US infants were more likely to perform imitative actions with the objects in Set B (M = .44, SD = .19) than the objects in Set A (M = .16, SD = .24, F[1, 16] = 19.26, p < .001) but this did not vary by first visit condition or first toy order condition and infants showed significant learning from baseline to test for both object sets (Set A: t[19] = 3.0, p = .008; Set B: t[19] = 10.4, p < .001).

Overall, US infants displayed higher imitation rates than the Mayan children from Study 1, F(1, 35) = 5.94, p = .02. However, caution should be exercised in interpreting absolute differences between these two communities, as US subjects may have had more experience in similar testing contexts, and may have been more comfortable in the presence of strangers (a rare occurrence for Mayan children) as compared to Mayan children. Thus, as other theorists have suggested (e.g. Lucy, 1992) it is likely more fruitful to consider patterns of learning within each culture than it is to make direct cross-cultural comparisons.

In order to assess imitation rates within the US infants, a repeated measures ANOVA with condition (child-directed or observed) as a within-subjects measure and visit order (child-directed first visit or observed first visit) and toy set order (Set A first or Set B first) as between-subjects measures was conducted on infants' imitation score (test minus baseline), with child age as a covariate. There was a main effect of age, F(1, 16) = 10.01, p = .006, indicating that older infants showed more robust imitation than younger infants, but this did not vary by condition. Surprisingly, given prior findings, there was *no* main effect of condition (child-directed vs. observed), F (1, 16) = .004, p = .95, indicating that, overall, infants were not more likely to imitate when directly addressed than when observing. However, interestingly, there was a main effect of visit order (child-directed first visit or observed first visit), F(1, 16) = 6.25, p = .024, demonstrating that infants in the child-directed first order showed greater imitation rates than infants in the observed first visit order (see Figure 3). There was no interaction between condition and visit order, F(1,16) = .00, p = .99; no effect of toy set order, F(1,16) = .07, p = .79, and no interaction between toy set order and condition, F(1, 16) = .03, p = .88. Infants who were directly engaged on their first visit showed heightened imitation as compared to infants who observed the interaction on their first visit, and continued to display heighted imitation even when observing the interaction on the second day. In contrast, infants who observed the interaction on their first visit showed decreased imitation rates that carried over to their second visit, even when they were directly addressed.

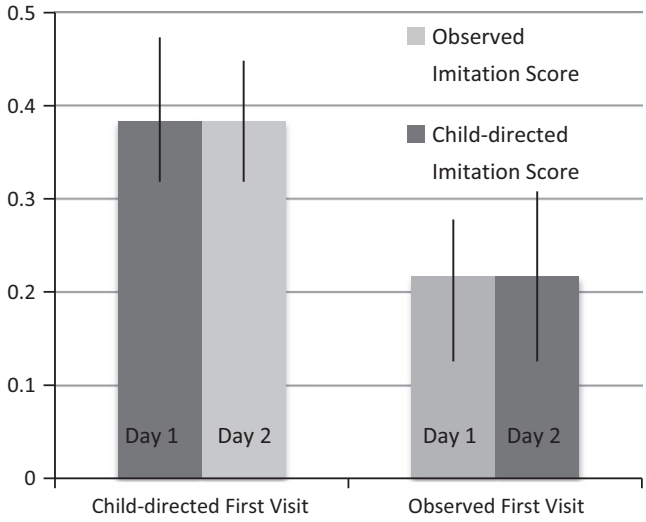

Figure 3 *Proportion of manner-actions imitated (test minus baseline) in the Observed and Child-directed conditions for US children in the Child-directed first and the Observed first visit orders.*

Thus, changing a previously used study design (e.g. Shneidman *et al*., 2014) from between-subjects to within-subjects yielded a surprising, and informative, pattern of results. Instead of always responding with increased imitation to child-directed contexts, US infants' responses depended on what kind of interaction they were a part of in their first visit to the lab. While we replicated the previously found pattern of results (e.g. Shneidman *et al*., 2014) on the first visit day, on the second day infants who had been previously directly addressed continued to show heightened imitative learning, even when they observed the interaction, while infants who had been previously ignored by the demonstrator continued to show more limited imitative behaviors, even when directly addressed. These results are not consistent with the idea that child-directedness triggers a particular kind of learning. Instead, US children seemed to be using their previous experience in a specific learning context in order to reason pragmatically about what actions to imitate.

General discussion

Our goal was to evaluate the role that child-directed interactions play in early social learning. We considered whether increased imitative learning from child-directed as compared to observational contexts is a universal constant, or instead reflects social strategies derived from frequent participation in child-directed interactions. In

Study 1, we found that, for Yucatec Mayan infants, directedness was not an informative cue for fostering imitative behaviors in any way. While Mayan infants generally increased imitative behaviors across the two study days (imitating more robustly on day two than on day one), neither the condition they were in nor the visit order they were assigned to related to their imitation. In Study 2, we considered US infants' responses in the same within-subjects paradigm. We expected that for US infants the results from this design would mirror previously reported results from between-subjects designs. In other words, we expected that infants would show heightened imitation when directly addressed as compared to when observing a third party interaction. However, surprisingly, there were no differences in imitative behavior in the child-directed and observed conditions. Instead, we found that infants who were directly addressed on their first visit showed significantly higher overall imitation rates than infants who observed on their first visit.

Theorists have argued that child-directed interactions provide a critical, a priori value for infants either because these contexts facilitate infants' intentional understanding (e.g. Barresi & Moore, 1996; Moore, 2010; Tomasello, 1995, 1999) or because they activate an innate stance to treat information as culturally relevant and generalizable (Csibra & Gergely, 2006, 2009, 2011). Our results from both US and Mayan infants call these assumptions into question. Even for infants growing up in contexts where child-directed situations are commonplace, directed cues do not seem to be the critical factor affecting learning in the moment. If they were, one would expect them to always inform imitation, regardless of what kind of prior information infants had about a given learning situation. Instead, US infants seem to be keeping track of their interaction history in a specific learning context (the laboratory) or with a specific person (the demonstrator), and then using this information to inform their imitative behaviors. Infants who were directly addressed on their first visit may have reasoned that the demonstrator had information that was relevant for them, and thus continued to imitate her actions on the second day, even when she was no longer directly addressing them. In contrast, the infants who were ignored by the demonstrator on the first day may have reasoned that the information she provided was irrelevant for them, and thus disregarded her actions even when they were eventually directly engaged by her. Thus, instead of being an automatic cue that always supports imitation, the value of child-directed contexts could depend on infants' pragmatic reasoning about the relevance that communicated information has within a situation.

Importantly, this reasoning may vary depending on infants' everyday social experiences. While US infants' imitative behaviors related to the condition they were first assigned to, for Mayan infants child-directed cuing did not relate to imitative behavior in any way. This suggests that infants' thinking about what counts as informative could vary based on the kinds of social cuing they regularly encounter. Infants growing up in communities where instructional engagement is commonplace could learn that child-directed contexts are particularly informative for marking information as important, or for signaling when and how they should respond to others. In contrast, infants who are more rarely directly engaged could use different kinds of social markers to inform their imitative learning. Indeed, there are many social cues, other than directedness, that have been shown to moderate infants' imitation of others' actions. For example, seeing the same action done by multiple people in the same way (Herrmann, Legare, Harris & Whitehouse, 2013), hearing conventional labels for actions (Chen & Waxman, 2013), or observing the actions of individuals who have special social relevance to a child (Buttelmann, Zmyj, Daum & Carpenter, 2013; Howard, Henderson, Carrazza, & Woodward, 2014; Shimpi, Akhtar & Moore, 2013) have all been found, in some cases, to increase young children's imitation of others. These factors could support children's interpretation of culturally relevant information even outside of episodes of child-directed interaction.

Moreover, if the importance of child-directed input depends on early social experiences, one might expect that variations in this experience, even within a culture, could relate to what information infants can or will extract from others' actions. For example, New Zealand infants who have older siblings are more likely to imitate actions without explicit instruction as compared to infants without siblings (Barr & Hayne, 2003) and US infants who have more daily opportunities to observe adult conversations are more skilled at attending to and learning from observed conversations than children with less of this experience (Shneidman, Buresh, Shimpi, Knight-Schwarz & Woodward, 2009). Further work is needed to elucidate whether and how infants' learning strategies relate to within-cultural variations in child-directed interactions.

A second question raised by the current findings is the extent to which infants' responses to child-directed and observed learning opportunities are mediated by their ability to regulate their attention during a social interaction. Infants who are accustomed to being directly addressed may become reliant on others' management of their attention, while infants who have less experience with directed teaching may be more able to independently monitor events that do not directly involve them (e.g. Correa-Chávez & Rogoff, 2009; Paradise, Mejía-Arauz,

Silva, Dexter & Rogoff, 2014). In constrained experimental paradigms such as the ones described here (where children's potential attentional foci are very limited), US children display heightened imitation following child-directed interaction as compared to observation *even* when they pay equal attention to these contexts (e.g. Sage & Baldwin, 2011; Shneidman *et al*., 2014). This suggests that child-directed situations provide informational value for these children beyond the way they shape attention in the moment. Nevertheless, attention matters for learning, and an open question concerns the way social experiences shape children's attention and imitative behaviors in more naturalistic contexts.

In sum, the results of these studies are incompatible with theoretical models that assume that child-directed interactions have critical, a priori informational value for young learners. Even for US infants growing up in a cultural context where child-directed interactions are commonplace, directed cues do not automatically increase infants' learning. Instead, infants seem to be utilizing child-directed cuing while tracking their interaction history in order to reason about what information is important or relevant in the context. For Mayan infants, who are more rarely directly engaged in pedagogical contexts, child-directed cuing does not relate to infants' imitation. Together these findings open the possibility that child-directed, pedagogical contexts come to acquire importance based on infants' early social experiences, which are in turn organized by cultural understandings. Instead of being a marker that always signals what infants should or can learn, directedness could be just one of many social cues that infants utilize in order to make sense of their complex social worlds.

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References

Akhtar, N., & Tomasello, M. (1998). Intersubjectivity in early language learning and use. In S. Braten (Ed.), *Intersubjective communication and emotion in early ontogeny* (pp. 316–335). New York: Cambridge University Press.

Barr, R., & Hayne, H. (2003). It's not what you know it's who you know: older siblings facilitate imitation during infancy. *International Journal of Early Years Education*, **11**, 7–21.

Barresi, J., & Moore, C. (1996). Intentional relations and social understanding. *Behavioral and Brain Sciences*, **19**, 107–122.

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

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.

Chen, M.L., & Waxman, S.R. (2013). 'Shall we blick?': novel words highlight actors' underlying intentions for 14-month-old infants. *Developmental Psychology*, **49** (3), 426–431.

Correa-Chávez, M., & Rogoff, B. (2009). Children's attention to interactions directed to others: Guatemalan Mayan and European American patterns. *Developmental Psychology*, **45**, 630–641.

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* (Vol. XXI, pp. 249–274). New York: Oxford University Press.

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

Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B*, **366**, 1149–1157.

de Leon, L. (1998). The emergent participant: interactive patterns in the socialization of Tzotzil (Mayan) infants. *Journal of Linguistic Anthropology*, **8**, 131–161.

Gaskins, S. (1999). Children's daily lives in a Mayan village: a case study of culturally constructed roles and activities. In A. Göncü (Ed.), *Children's engagement in the world: Sociocultural perspectives* (pp. 25–60). New York: Cambridge University Press.

Gaskins, S. (2006). Cultural perspectives on infant–caregiver interaction. In N.J. Enfield & S.C. Levinson (Eds.), *Roots of human sociality: Culture, cognition and interaction* (pp. 279–298). Oxford: Berg.

Gaskins, S., & Paradise, R. (2010). Learning through observation in daily life. In D.F. Lancy, J.C. Bock, & S. Gaskins (Eds.), *The anthropology of learning in childhood* (pp. 85–117). Walnut Creek, CA: AltaMira Press.

Herold, K.H., & Akhtar, N. (2008). Imitative learning from a third-party interaction: relations with self-recognition and perspective taking. *Journal of Experimental Child Psychology*, **101** (2), 114–123. doi:10.1016/j.jecp.2008.05.004

Herrmann, P.A., Legare, C.H., Harris, P.L., & Whitehouse, H. (2013). Stick to the script: the effect of witnessing multiple actors on children's imitation. *Cognition*, **129**, 536–543.

Howard, L.H., Henderson, A.M.E., Carrazza, C., & Woodward, A. (2014). Infants and young children's imitation of

linguistic ingroup and outgroup informants. *Child Development*, **86**, 259–275.

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

Lieven, E.V.M. (1994). Crosslinguistic and crosscultural aspects of language addressed to children. In C. Gallaway & B.J. Richards (Eds.), *Input and interaction in language acquisition* (pp. 56–73). Cambridge: Cambridge University Press.

Lucy, J. (1992). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis.* Cambridge: Cambridge University.

Matheson, H., Moore, C., & Akhtar, N. (2013). The development of social learning in interactive and observational contexts. *Journal of Experimental Child Psychology*, **114**, 161–172.

Moll, H., & Tomasello, M. (2007). How 14- and 18-month-olds know what others have experienced. *Developmental Psychology*, **43**, 309–317. doi:10.1037/0012-1649.43.2.309

Moore, C. (2010). Understanding self and others in the second year. In C.A. Brownell & C.B. Kopp (Eds.), *Socioemotional development in the toddler years: Transitions and transformations* (pp. 43–65). New York: Guilford.

Nielsen, M. (2006). Copying actions and copying outcomes: social learning through the second year. *Developmental Psychology*, **42**, 555–565.

Ochs, E., & Schieffelin, B. (1994). Language acquisition and socialization: three developmental stories and their implications. Reprinted in B. Blount (Ed.), *Language, culture, and society: A book of readings* (pp. 470–512). Prospect Heights, IL: Waveland Press.

Paradise, R., Mejía-Arauz, R., Silva, K.G., Dexter, A.L., & Rogoff, B. (2014). One, two, three, eyes on me! Adults attempting control versus guiding in support of initiative. *Human Development*, **57**, 131–149.

Pye, C. (1986). An ethnography of Mayan speech to children. *Working Papers in Child Language*, **1**, 30–58.

Rogoff, B. (2003). *The cultural nature of human development*. Oxford: Oxford University Press.

Rogoff, B., Mistry, J., Göncü, A., & Mosier, C. (1993). Guided participation in cultural activity by toddlers and caregivers. *Monographs of the Society for Research in Child Development*, **58** (8), 179. doi:10.2307/1166109

Sage, K.D., & Baldwin, D. (2011). Disentangling the social and the pedagogical in infants' learning about tool-use. *Social Development*, **20** (4), 825–844. doi:10.1111/j.1467-9507.2011.00624.x

Shimpi, P., Akhtar, N., & Moore, C. (2013). Toddlers' imitative learning in interactive and observational contexts: the role of age and familiarity of the model. *Journal of Experimental Child Psychology*, **116**, 309–323.

Shneidman, L.A., Buresh, J.S., Shimpi, P.M., Knight-Schwarz, J., & Woodward, A.L. (2009). Social experience, social attention and word learning in an overhearing paradigm. *Language Learning and Development*, **5** (4), 266–281. doi:10.1080/15475440903001115

Shneidman, L.A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: how important is directed speech? *Developmental Science*, **15**, 659–673. doi:10.1111/j.1467-7687.2012.01168.x

Shneidman, L., Todd, R., & Woodward, A.L. (2014). Why do directed interactions support imitative learning in young children? *PLoS ONE*, **9** (10), e110891.

Shneidman, L., & Woodward, A.L. (2014). Are child directed interactions the cradle of social learning? Under revision.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore, P. Dunham, & J. Philip (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Lawrence Erlbaum Associates.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

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