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Child-directed action promotes 2-year-olds' imitation

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ABSTRACT

Children are voracious learners and adults are ubiquitous teachers. This project investigates whether the special infant-directed action modifications parents use when teaching their children (called "motionese"; Brand, Baldwin, & Ashburn, 2002) improves two-year-olds' imitation. Children saw an adult perform a series of acts on four novel objects, using either an infant-directed style (including larger range of motion and enhanced boundary marking) or an adult-directed style. Children's imitation of the acts was higher in the infant-directed relative to the adult-directed condition, and both types of demonstration increased imitation relative to baseline (no demonstration). We propose that motionese may also provide information about actions, objects, and intentionality, thus enhancing toddlers' observational learning.

A young child watching her parents do something as mundane as cleaning the kitchen is privy to thousands of years of accumulated knowledge, including examples of tool use (e.g., sweeping with a broom) and subtle action techniques (a wrist twist to disassemble a blender). While opportunities to witness such behaviors are abundant, learning from and copying these examples is likely more challenging than it may first appear. For instance, children need to distinguish the intentional (e.g., sweeping) from the incidental (e.g., sneezing) and the means (right-to-left motion) from the ends (dirt removal). Evidence from non-human animals and children with autism illustrate the difficulties in navigating these challenges (e.g. Rogers & Williams, 2006; Whiten, Horner, Litchfield & Marshall-Pescini, 2004). Nevertheless, young children are proficient imitators (Barr, Dowden, & Hayne, 1996; Meltzoff, 1988). The current project investigates whether parental teaching, in the form of “motionese,” or “infant-directed action,” (Brand, Baldwin, & Ashburn, 2002; Rohlfing, Fritch, Wrede, & Jungmann, 2006) contributes to children’s success at imitating novel actions.

In their endeavor to understand others’ actions on objects, children are not typically expected to learn through mere observation. Rather, parents provide support for social learning (Bjorklund, Causey, & Periss, 2010). Teaching – behavior enacted seemingly for the sole purpose of educating another (Caro & Hauser, 1992) – is common. In fact, both adults and children are known to tutor less knowledgeable others (Csibra & Gergely, 2005; 2011; Flynn, 2010). Although there is debate about what counts as teaching across cultures and across species (Caro & Hauser, 1992), there is no question that children in the Western industrialized world are exposed to massive amounts of instruction from infancy through their school years. Particularly when defined to include non-verbal re-directing and opportunity provisioning, teaching appears to be a human universal (Caro & Hauser, 1992).

In fact, when teaching about novel objects to infants aged 6 to 13 months as opposed to adults, a particular suite of embellished behavior emerges, which has been called “motionese” or “infant-directed action” (Brand et al., 2002; Rohlfing et al., 2006). These behaviors incorporate some previously-studied features such as eye gaze and emotional expressiveness (Chong, Werker, Russell, & Carroll, 2000; Hains & Muir, 1996), but also involve a variety of other modifications. These include closer proximity to a child versus adult partner; greater enthusiasm; a larger range of motion; simplified action sequences; greater repetitiveness; as well as higher interactiveness, including more and longer gazes to infants’ faces and more turn-taking. Extensions to this work have also found evidence of longer pauses in infant-directed compared to adult-directed action (Rohlfing et al., 2006) and a unique coordination of speech and action in demonstrations for children (Meyer, Hard, Brand, McGarvey, & Baldwin, 2011; Schillingmann, Wrede, & Rohlfing, 2009).

An important question about motionese is whether it is effective as a teaching behavior. Although it is possible that this medley of cues could be distracting or frustrating relative to the straightforward adult-directed action style, we think it more likely that these cues function to provide a richer learning experience than does a standard demonstration. If so, then motionese would fit within a suite of behavioral adjustments for children, including “infant-directed” speech (e.g., Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989; Kuhl et al., 1997), facial expressions (Chong et al., 2003), singing (Trehub & Trainor, 1998) and gestures (Iverson, Capirci, Longobardi, & Caselli, 1999; Masataka, 1996), some of which have been shown to have pedagogical functions (e.g., Thiessen, Hill, & Saffran, 2005).

To the extent that motionese is an effective teaching tool, it is important to discover how it functions. One possibility is that motionese may improve learning by triggering a pedagogical stance. Csibra & Gergely (2005) have proposed that humans have an evolutionary adaptation such that when presenting new information, adults create and children respond to a pedagogical context. According to this account, children are sensitive to cues from adults that highlight new and important information; children are more likely to imitate acts that are marked as intentional and demonstrated *for* them. For example, if infants simply *witness* an adult bend over and touch a lamp with the head in order to illuminate it (as in Meltzoff, 1988), rather than having the adult specifically *show* them after making eye contact, infants are less likely to imitate it (Kiraly, Csibra, & Gergely, 2004, as referenced in Gergely & Csibra, 2006). Motionese includes cues that have been proposed to establish a pedagogical context, such as making eye contact before a demonstration (Senju & Csibra, 2008). If motionese is important for establishing a pedagogical context alone, we would expect similar levels of imitation in infant-directed relative to adult-directed demonstrations, as long as both are presented in an intentional, pedagogical fashion.

A related possibility is that the motionese behavioral modifications (e.g., large motions, increased eye contact) draw or retain children's attention to the demonstrations. Given young children's fledgling attentional control (Ruff & Rothbart, 1996), a system of exaggerated behaviors throughout a demonstration could arguably be important for the sheer purpose of keeping young children engaged with the activity. In support of this possibility, motionese has been shown to preferentially attract children's attention; 6- to 13-month-olds looked longer at infant-directed (ID) versus adult-directed (AD) demonstrations when both were available to view simultaneously (Brand & Shallcross, 2008; see also Koterba & Iverson, 2009). This was true even when the faces were digitally blurred, to obscure eye gaze and expression information, suggesting a role for the entire suite of behaviors, and not simply facial cues. Increased scrutiny or interest in the behaviors could lead children to encode and remember the actions better for subsequent imitation.

Motionese also may have functions beyond attracting children's attention or preparing them for new information. Motionese modifications may also help to make demonstrated acts easier to parse (e.g., by highlighting boundary points with repetition and eye gaze; Brand et al., 2009; Brand, Hollenbeck, & Kominsky, 2013); stress which body parts and subtle physical motions are necessary (e.g., a horizontal twist before vertically pulling off a cap); and highlight the intentions behind the acts (e.g., by exaggerating facial expressions of surprise and satisfaction). If motionese functions in this way, children may learn more easily, and imitate more faithfully, when the suite of cues is shown throughout the demonstration.

The current experiment is a direct test of whether motionese influences young children's observational learning of novel acts. The primary goal is to determine whether a demonstration enhanced with motionese promotes imitation relative to a more streamlined, but still pedagogical, adult-directed demonstration. We also include a no-demonstration baseline control. Children's performance in this group will provide a measure of their spontaneous rates of producing the targeted acts, and will allow us to assess whether children in the other groups learn from the adult's demonstration. We test two-year-olds because this is an age group that can imitate multiple acts and action types (Nagell, Olguin, & Tomasello, 1993), though they sometimes still struggle with imitating sequences of acts, including those using tools, in order to reach an outcome (Carpenter, Call, & Tomasello, 2005; Want & Harris, 2001). We expected this age group to have variability in their imitation of sequences of acts, and thus room to improve when motionese features were added to a demonstration.

Method

Participants

Participants were 48 children (24-31 months, *M* =27 months; 25 males), recruited by telephone through a University's child participant list. Parental self-report identified the sample as 19% African American, 2% Asian, 6% Hispanic, 4% mixed race, 65% white, and 4% other/unknown. Four additional children's data were excluded due to experimenter error.

Materials

Four novel objects were designed for this procedure (see Table 1). The objects include a *lift-top box,* a box (20 x 17 x 6 cm) with a non-functional switch on the top with a lid that can be lifted with a pronged tool to reveal a slinky; a *music machine*, an audio speaker (11 x 8 x 13 cm) with an attached grating that can be strummed with a pick and creates a sound; a *snap container*, a container (16 x 16 x 5 cm) that has snap sides and a handled lid that can be removed with a foam tool to reveal a toy; and a *mounted light*, a touch-sensitive light mounted on a fabric-covered base (14 cm tall, 13 cm diameter).

Design and Procedure

In all groups, an experimenter sat across a table (81 x 81 cm) from the child in a quiet laboratory room. The sessions were video-recorded. Each child was randomly assigned to one of three independent groups: baseline, adult-directed action (AD), or infant-directed action (ID). There were 16 children in each group. There was a demonstration and a test phase for each of the four objects (children in the baseline group received no demonstration). The objects were presented in two different orders, which were counterbalanced between children.

Table 1
Detailed Stimuli Description Including Photo, Target Acts, and Motionese Modifications Used in Infant-directed Demonstrations.

Stimuli	Photo	Target acts	Stimuli-specific motionese
Lift-top box		1. *flip* switch on top of box 2. *rotate* box so wooden handle is in line with the tool 3. *apply* tool around wooden handle 4. *open* the box (with or without tool) to reveal a slinky	• Marked action boundary (jiggling box before fully rotating, act 2) • Large range of motion (shifting shoulders, act 2)
Music Machine		1. *press* silver button at base of speaker 2. *turn* volume switch to the right and back to the left 3. *touch* the pick to the strings 4. *strum* the strings (with pick or hand) to make a sound	• Marked action boundary (repeated lifting of pick from hook, before act 3) • Large range of motion (extended forearm sweep, act 3)
Snap Container		1. *lift* the handle on top of the box 2. *unsnap* the side latch 3. *apply* the tool to the lid 4. *open* the container (with or without tool, with or without unsnapping) to reveal a toy	• Marked action boundary (pointing to handle and eye contact, before act 1) • Large range of motion (exaggerated arm raise, act 3)
Mounted Light		1. *remove* black band from the base 2. *press* button 3. *touch* the top of the light with the back of the hand 4. *press* the light to illuminate	• Marked action boundary (rotating raised hand, between act 2 and 3) • Large range of motion (act 2 and 3)

Demonstration. In the AD and ID groups, an experimenter performed four distinctive acts on the objects, see Table 1. None of the target acts depended on each other; each could be completed independently (e.g., the lift-top box can be pulled open using one's hand rather than with the tool). However, each sequence of acts was designed to be a plausibly necessary to reach the end goal. For each object, the order of the actions was always the same and each demonstration was presented only once.

In both the AD and ID groups, the experimenter drew the child's attention ("It's my turn now, watch,") and made eye contact before beginning the demonstration. Thus, across both groups, the demonstration was set in a pedagogical context and there were indications that an intentional demonstration was occurring. In the AD group, the experimenter kept a neutral facial expression, acted in a reserved manner, and made limited eye contact during the demonstration. In the ID group, modifications were made to these standard AD demonstrations. The modifications were chosen based on characterizations of mothers' spontaneous behaviors that were observed in a past study of motionese (Brand et al., 2002.) A research assistant, who was the mother of small children, was video-recorded performing the chosen manipulations. This video was used as a guide for training the experimenters to perform the live demonstrations.

Three types of motionese modifications were added to each demonstration in the ID group (see Table 1 for specific modifications for each action). For one, throughout all ID demonstrations, the experimenter was emotionally engaging, smiling and leaning forward during the demonstration. Second, the experimenter used a large range of motion for specific acts. Finally, the experimenter marked action boundaries in one of several ways. Specifically, she made eye contact between key actions (as in Brand et al., 2013); pointed to specific parts of the object before acting on them; and highlighted body parts before using them (e.g., rotating the hand several times before using the back of the hand to turn on the light).

Test. After each demonstration, the children received the test period for that object. The children in the baseline group saw no demonstration and participated in the test phase only. The test phase was the same for all groups. The experimenter told the children that they could take a turn, gave them the object (and tool, when appropriate), and allowed them to play for 25 s.

Scoring and Dependent Measures

From video, research staff scored each child's production of the target acts for each object during the 25 s test period. A dichotomous yes/no (1/0) measure was used, and children were credited with a 1 for each act they were judged to have performed. The average score across the four objects was taken, resulting in a *target acts score* that ranged from 0-4 points per object. As a measure of attention, research staff scored the amount of time the children watched each demonstration to the video frame (30/second). One child's looking could not be recorded due to a bad camera angle. A second scorer, who did not know the hypothesis of the study or the children's group assignment, coded a randomly chosen quarter of the subjects' trials. Inter-rater reliabilities for the target acts score (kappa = .91) and video attention durations (interclass correlation coefficient = .97) were strong.

Results

Preliminary analyses showed no significant effects of object presentation order, trial number, object, or gender on the target acts score; we collapsed across these factors for subsequent analyses. Additionally, an analysis of children's looking suggested high attention to both demonstrations. Children watched on average 97.5% (SD = 6.1%) of the ID and 97.2% (SD = 9.3%) of the AD demonstration. There was no difference between the groups, t (29) = .11, p = .92, d = .04.

An Analysis of Variance (ANOVA) on children's target act scores revealed a main effect of test group (see Figure 1), F (2, 45) = 20.27, p < .001, $\eta_p{}^2$ = .47. Planned follow-up comparisons using the Student-Newman-Keuls (SNK) method showed significant differences among all three groups (p < .05). As predicted, children in the infant-directed action group had higher target act scores (M = 2.33 acts per object, SD = 0.45) than did children in the adult-directed action group (M = 1.92 acts per object, SD = 0.69) who in turn had higher scores than those in the baseline group (M = 1.13 acts per object, SD = 0.45).

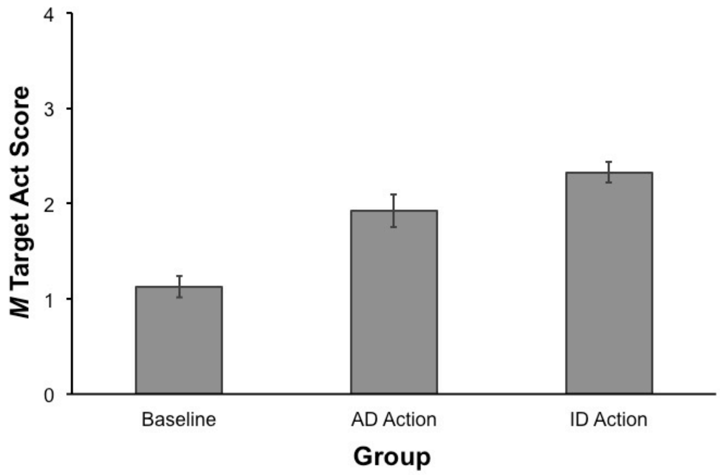

Figure 1. Mean target act score per object (plus and minus standard error) as a function of experimental group.

Discussion

Humans are ubiquitous teachers (Csibra & Gergely, 2011), but not all teaching looks the same. When teaching children about new objects, parents use an array of special pedagogical modifications beyond what is typical for teaching adults. This experiment investigated whether these modifications are effective in fostering children's imitation of novel actions. Overall, teaching worked: children who saw any demonstration (either ID or AD) showed imitation, in that they were more likely to produce the target acts than were children in a no-demonstration baseline group. Importantly, ID demonstrations were particularly effective teaching behaviors. Children who saw demonstrations augmented with motionese showed even higher levels of imitation than did children who saw AD demonstrations. Thus, this report provides the first evidence that motionese enhances imitation.

The current results also begin to address how these cues function. One possibility we explored was that motionese merely functions to trigger the pedagogical stance (Gergely & Csibra, 2006), which on its own has been shown to enhance imitation (Brugger et al. 2007; Nielsen, 2006). This appears not to be an adequate explanation. In both the AD and ID conditions the experimenter set up a pedagogical stance, by making eye contact and drawing the child's attention before the demonstration. Nevertheless, children imitated significantly more in the ID condition, hinting at additional functions of motionese.

Although past studies using videoed models suggest that motionese is more engaging than adult-directed action (Brand & Shallcross, 2008), children's overt attention to the two types of displays did not differ in the current study. The lack of relationship between imitation and looking time raises the possibility that the range of cues used in motionese provides multiple benefits to learners. In addition to drawing attention and setting the pedagogical context, the mechanics of motionese may highlight the specific actions used in a demonstration. For instance, the timing of the demonstrators' eye gaze and repetition may help to break up action streams into smaller units for analysis (Brand et al., 2009; Brand et al., 2013). In addition, the large range of motion might serve to draw attention to relevant parts of an object (e.g., a small button), as well as to the body parts and trajectory to use in order to successfully manipulate the object (e.g., a strong downward press with a finger). The fact that mothers vary the characteristics of eye gaze and repetition across development (Brand, Shallcross, Sabatos, & Massie, 2007) and across teaching context (Brand et al., 2009; Brand et al., 2013) supports the idea that specific mechanical changes may provide diverse and subtle benefits.

The motionese modifications may also make acts look more intentional, for instance, by exaggerating goal-directed movements and emotional expressions of satisfaction at the completion of goals. Past studies have shown that intentionality influences imitation. When experimenters have made actions look *less* intentional than a standard demonstration by appearing to act accidentally (Carpenter, Akhtar, & Tomasello, 1998) or being non-human (e.g., Meltzoff, 1995; Hopper, 2010), children show less imitation. In contrast, motionese may function to make a demonstration appear *more* intentional. The current results suggest that even among obviously intentional acts, exaggerating the goals and desires of the actor may enhance imitation. Future research should address whether the suggested functions of action segmenting and intention highlighting are borne out, and further whether it can be demonstrated that specific features of the motionese suite of behaviors are responsible for these effects.

An important area for future research is to determine the ubiquity of such modifications in young children's experiences. The original study characterizing motionese (Brand et al., 2002) was conducted with mothers of infants. Additional research suggests that fathers provide similar, if not identical, modifications (Rohlfing et al., 2006; Rutherford & Przednowek, 2012). Given that even children adjust their language for younger siblings (Dunn & Kendrick, 1982), it is possible that other behavioral examples, such as those provided by siblings and peers (Barr & Hayne, 2003; Hanna & Meltzoff, 1996), also include motionese. In sum, it is likely that motionese is a form of teaching that young children regularly receive in informal learning contexts.

Whether and to what extent motionese is typically provided for children beyond infancy is also an open question. From informal observations, we believe motionese is used through the toddler years, and toddlers were used in the current study because of their greater facility with a broader variety of object-directed actions than infants. However, to our knowledge, no formal investigations with children over 13 months have been conducted. An important future direction is to align formal characterizations of motionese with tests of its effectiveness. Doing so may be particularly helpful for promoting action-based learning in young children, as it may reveal which specific modifications are most effective for different developmental levels and contexts.

In sum, the current study indicates that the suite of infant-directed action modifications known as motionese influences young children's imitation of novel acts. During both the AD and ID demonstrations, the adult was always attentive to the child and completed the series of actions in a purposeful way. The only differences were modifications of the type spontaneously offered by adults for infants, including changes to facial expression, boundary marking, and range of motion. These results show that demonstrations using such modifications can promote children's observational learning, and may help to explain the rapidity with which children master the myriad tools and toys in their daily environment.

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