INVESTIGATING MOTIONESE: THE IMPACT OF INFANT-DIRECTED ACTION ON INFANTS' PREFERENCE AND LEARNING

by

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ABSTRACT

Adults often modify their speech, gesture, sign language, and action when interacting with infants relative to adults. Some of these forms of infant-directed communication have been tied to infant preferences and learning, but infant-directed action has yet to be investigated. The purpose of the present study was to test whether infant-directed action impacts infants' preferences and learning. Forty-eight 8 to 10 month old infants and their caregivers participated in a laboratory session during which caregivers demonstrated stimuli to infants using infant-directed action or a static presentation. Infants' preferences were investigated through touches and looks to stimuli. Results indicate that infants appear to prefer infant-directed action and make stimulus-action associations, indicating that infant-directed action is indeed parallel to other forms of infant-directed communication.

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1.0 INTRODUCTION

Parents appear to have a natural ability to interact with their children in ways that are appropriate for the child's level of understanding. When adults communicate with infants, that communication is qualitatively different from communication with adults. Research has documented four specific types of communication that differ when the communicative partner is an infant. These include infant-directed speech, infant-directed sign language, infant-directed gesture, and infant-directed action. A review of each of these four types of communication will provide insight into how adults modify their behavior in communication with infants.

1.1 INFANT-DIRECTED COMMUNICATION

In many cultures around the world, though not all (Ochs & Schieffelin, 1995; Pye, 1992), adults and older children speak to infants differently than they do to peers (Newport, 1977). Speech to infants is characterized by a higher pitch, shorter length of utterance, more exaggerated intonation contours, and content simplification and limitation to shared experiences (e.g., Snow, 1991; Stern, Spieker, & MacKain, 1982). This tendency for adults and older children to use infant-directed speech is also known as "motherese" (see Snow, 1991, for review).

Motherese has also been detected in infant-directed communication in the manual modality. Masataka (1992) illustrated the ways in which deaf Japanese caregivers differ in their communication to deaf infants versus deaf adults. Signs used with infants were characteristically slower and involved high levels of repetition and exaggerated movements. These characteristics are strikingly similar to those observed in infant-directed speech produced by hearing caregivers, and it suggests that motherese is not modality specific (Masataka, 1996).

Motherese also appears in gesture. In a study involving Italian caregivers and infants, Iverson, Capirci, Longobardi, and Caselli (1999) found evidence that gestures differed both quantitatively and qualitatively when mothers were interacting with infants versus adults: in caregiver-infant interactions, caregivers used gestures less frequently, and when gestures were used, they tended to co-occur with speech and to reinforce the content in the speech.

Recent work indicates that characteristics of motherese are also present in action directed toward infants. Brand, Baldwin, and Ashburn (2002) investigated the properties of actions produced by 51 caregivers engaged in communication with either their own infant or a well-known adult. The caregivers were given five novel objects and instructions which described how the objects worked. They then were allowed to interact naturally with their partner (child or adult) while using each object.

Results indicated that caregivers modified object-related actions when involved in interactions with infants. The authors termed this tendency “motionese” and defined eight action parameters that differed when the communicative partner was an infant versus an adult. Relative to adult-directed action, infant-directed actions occurred in closer proximity to the partner, involved higher interactiveness, more enthusiasm and more repetition, were slower and simpler, had increased amplification in the form of the range of the movement, and involved more punctuation in the form of pauses and sharper movements.

1.2 DO INFANTS PREFER INFANT-DIRECTED COMMUNICATION?

The above evidence indicates that caregivers modify speech, sign, gesture, and action in the presence of infants. This leads naturally to the question of whether infants demonstrate preferences for motherese. Evidence from speech and sign suggests that infants prefer motherese. For example, one month old infants prefer motherese spoken by an unfamiliar female to adult-directed speech, and four month old infants prefer motherese spoken by both a familiar and an unfamiliar female to adult-directed speech (Cooper, Abraham, Berman, & Staska, 1997; Fernald, 1985). Also, Werker and McCleod (1989) showed that infants display more positive affect in the presence of motherese than in the presence of adult-directed speech.

With regard to manual motherese, Masataka (1996) showed that deaf infants prefer to look at signs directed towards infants than at signs directed toward adults. In a follow-up study, Masataka (1998) discovered that hearing infants with no prior exposure to sign language also preferred infant-directed to adult-directed sign.

Although it is clear that infants prefer motherese in both spoken and manual forms, it is as yet unknown whether infants demonstrate a similar preference for motionese over unmodified action. Therefore, one goal of this study is to assess whether infants prefer action with more parameters of motionese, action with fewer parameters of motionese, or no movement.

1.3 DO INFANTS LEARN FROM INFANT-DIRECTED COMMUNICATION?

Although infants appear to prefer infant-directed communication in the form of speech, sign language, and gesture, it is unclear whether the modification in infant-directed speech serves a psychological function. Some researchers have argued that infant-directed communication facilitates learning (e.g., Brand, Baldwin, & Ashburn, 2002; Fernald, Taeschner, Dunn, & Papousek, 1989; Snow & Ferguson, 1977). Features such as grammatical simplicity, redundancy, and semantic restrictions evident in infant-directed speech may help children break down information in the content stream (Snow, 1991). Indeed, redundancy and grammatical simplicity are associated with more rapid language processing in two-year olds (Barnes, Gutfreund, Satterly, & Wells, 1983). In Snow's view, motherese may also allow children to understand typical conversations and turn-taking and help delineate linguistic boundaries:

> Children hear a relatively small number of words over and over again – a fact which must help them immensely in the difficult task of segmenting the stream of speech they hear into meaningful units. Furthermore, children hear phrases from sentences repeated out of context and in new contexts. (1991, p. 205)

Infant-directed gestures have also been tied to infant learning. For example, Iverson et al. (1999) showed that mothers' gesture production was correlated with infant vocabulary size and gesture production at 16 months and with gesture production at 20 months, indicating that infants may benefit from mothers' gesture production.

With regard to a link between motionese and learning, Brand, Baldwin, and Ashburn (2002) have suggested that motionese may assist infants in learning about action just as motherese helps infants learn language. They believe that motionese may help maintain infants' attention to action, help infants understand structure in action, and allow infants to recognize the meaning behind an action.

This belief is not unreasonable. Just as spoken motherese might assist language learning by defining linguistic boundaries, motionese could help infants divide a sequence of action into units. Baird and Baldwin (2001) investigated the ability of adults and infants to parse an action stream into meaningful pieces. They found that 10 to 11 month old infants do parse action along intentional boundaries, much like adults. However, the question of whether infants are able to parse action before 10 months remains unanswered. Infants younger than 10 months may use motionese to assist in defining boundaries of movement, which develops into the ability to parse an action stream into meaningful units.

Another way in which motionese could influence infant learning is by providing redundant information. Gogate and Bahrick (1998, 2001) and Gogate, Bahrick, and Watson (2000) found that redundant information in vocalizations and gestures toward infants helps infants make connections between the two. For example, infants hearing a spoken syllable paired in synchrony with a moving object are better able to learn the association between that sound and the object. Gogate and Bahrick (1998, 2001) and Gogate, Bahrick, and Watson (2000) argue that it is the presence of redundant information that facilitates infants' learning of object-word associations. A potential connection to motionese is present. As described by Brand et al. (2002), motionese involves higher levels of repetition and greater movement amplitude. It is entirely possible that this adds redundancy to the information provided to the infant, which could in turn assist in learning. A second goal of this study, therefore, is to evaluate the hypothesis that motionese facilitates infant learning.

Although to date there has been no research to this effect, it seems likely that motionese might also motivate infants to engage and manipulate objects when they have the opportunity to do so. However, this possibility has not been put to a direct test. As a result, a third and final goal of this study is to assess the possible relevance of motionese to object manipulation.

Finally, because Brand et al.'s (2002) eight parameters of motionese have not been separately studied to identify whether a separate or additive effect exists, a more systematic approach to motionese is needed. The three goals presented above focus on the extent to which amplitude and repetition separately or in combination, play a role in infant preferences and learning.

1.4 PRESENT STUDY

In short, this study had three main goals: to examine whether infants prefer action with more parameters of motionese, action with fewer parameters of motionese, or no movement; to determine whether motionese assists infants in forming associations between movement and objects; and to investigate whether motionese heightens infant attention to and influences manipulation of objects. In addition, the study took a more systematic approach to Brand et al.'s (2002) eight defined parameters of movement present in motionese by focusing specifically on amplitude and repetition.

2.0 METHOD

2.1 PARTICIPANTS

Forty-eight typically-developing, healthy 8 to 10 month old infants (*M age* = 9 months, 13 days, *range* = 8 months, 3 days – 10 months, 28 days) and their primary caregivers participated in the study. This age range was chosen because it coincides with the period when infants become able to understand relationships between objects and people (Trevarthen & Hubley, 1978). Participants were recruited from a large, mid-Atlantic city and surrounding communities. Recruitment was primarily conducted through mailings targeted to families with an infant between the ages of 8 to 10 months. Participants were excluded if a) mothers were less than 18 years of age, b) no English was spoken in the home, c) infants were born at less than 35 weeks, d) infants weighed less than 5 pounds at birth, or e) extreme complications occurred during or immediately following childbirth. Twenty-four boys and 24 girls participated in the study, and all were from English-speaking households (infants: 81.25% Caucasian, 6.25% Asian, 4.2% African-American/Caucasian, 4.2% African-American, 2.1% Hispanic/Caucasian, 2.1 % Hispanic/African-American; caregivers: 83.3% Caucasian, 6.25% Asian, 4.2% African-American, 2.1% African-American/Caucasian, 2.1% Hispanic/Caucasian, 2.1% Hispanic). Of the 48 caregivers who participated in this study, 44 were mothers (*M age*= 31.11, *range* = 21-42) and 4 were fathers (*M age*= 31.25, *range*= 28-35). Data from an additional 3 dyads were excluded due to infant fussiness (2) and experimenter error (1).

2.2 LABORATORY SETUP

Infants and primary caregivers visited the laboratory for one session lasting approximately 30 minutes. Infants, who were seated in a high chair, and primary caregivers, who sat opposite to and facing the infants, interacted with separate video cameras focused on each participant. The two cameras fed into a screen splitter for later coding. The laboratory setup, depicted in Figure 1, also included two object display cases situated on either side of the caregiver with curtains that could be opened and closed. The display cases and the curtains were used to present two objects simultaneously to the infants during the Looking Time Test phase, as described below.

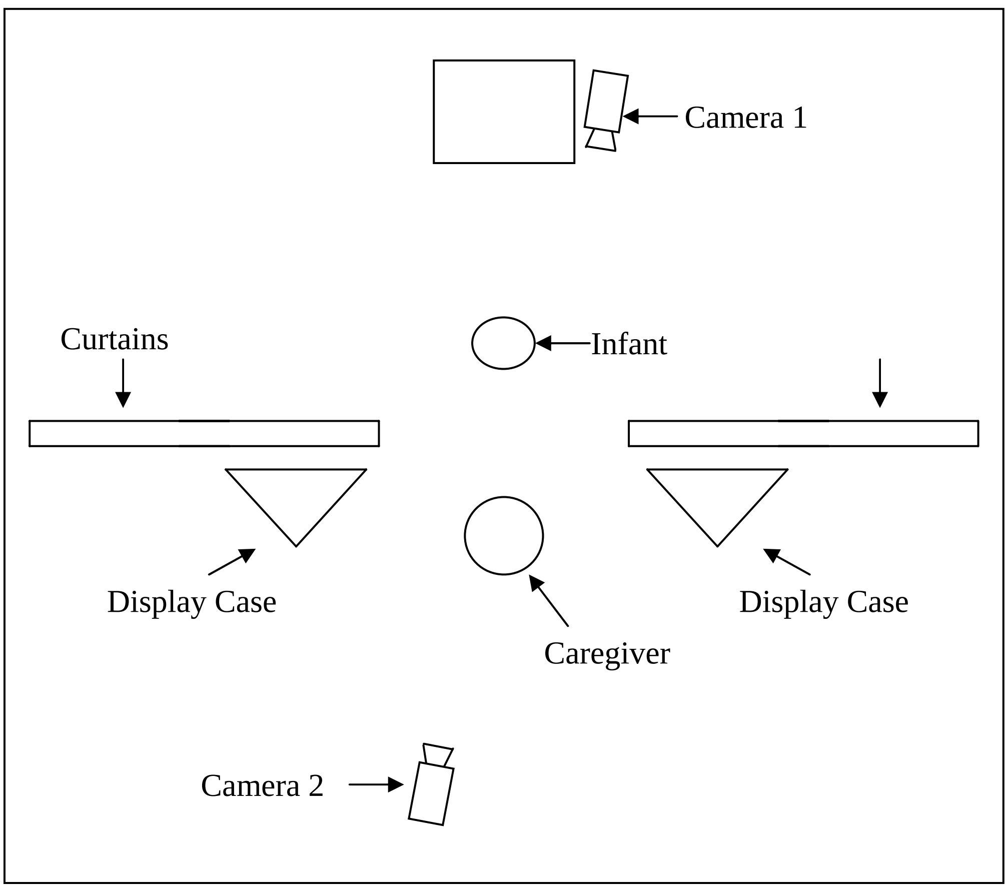

Figure 1. Laboratory set-up

2.3 PROCEDURE

The experiment consisted of four phases: a Warm-Up period, a Movement Training segment, a Looking Time Test phase and an Independent Play Test phase. The four phases are described below and depicted in Table 1.

Table 1. Overview of study phases

	Warm-Up	Movement Training	Looking Time Test	Independent Play Test
Total Trials	4	8 (4 target, 4 distracter)	4	4
Movement Demonstration	-----	5 seconds, repeated 3 times	5 seconds	-----
Time Per Trial	60 seconds	35 seconds	10 seconds	25 seconds
Total Time per Phase	4 minutes	8 minutes	4 minutes	4 minutes

2.3.1 Warm-up

At the beginning of the session, primary caregivers were informed that the goal of the study was to investigate infants' learning about objects. All dyads experienced the same warm-up period, regardless of Movement Training condition assignment (see below). In this phase, primary caregivers were asked to interact with their babies with stimuli (Brand et al., 2002). They were given four stimuli (see Figure 2), one at a time, and were asked to interact with their infants with the stimulus for 45 seconds as they would with any toy at home. They were given no further guidance or restrictions in terms of what types of actions to use with the stimuli. No coding was conducted for this phase for the present study as its primary purpose was to allow both caregiver and infant an opportunity to grow accustomed to the laboratory setting.

Figure 2. Warm-up objects

2.3.2 Movement training

In the Movement Training phase, four different movement conditions were created by varying the two primary action elements under investigation, amplitude and repetition, along two dimensions as follows: high amplitude/high repetition (HiAmp/HiRep), low amplitude/high repetition (LoAmp/HiRep), high amplitude/low repetition (HiAmp/LoRep), or low amplitude/low repetition (LoAmp/LoRep). Each condition had a corresponding DVD that demonstrated the target movement to the caregiver on the television screen (see Figure 1). Dyads were assigned to one of the four conditions prior to arrival at the laboratory. Condition assignment was randomly determined with the constraint that there were equal numbers of boys and girls in each group.

The target movement demonstrated in the HiAmp/HiRep Group consisted of a large up and down movement, stretching from caregiver waist to eye, repeated three additional times for a total of four movements. The LoAmp/HiRep Group exhibited a small up and down movement, stretching from caregiver chest to chin. This movement also was repeated three times. Caregivers in The HiAmp/LoRep Group demonstrated a large up and down movement, also from waist to eye, but it was not repeated. Finally, the LoAmp/LoRep Group displayed a small movement from chest to chin that was also not repeated.

To ensure that infants in each group were exposed to target movements for equal amounts of time, movement speed was by default varied. Rates for the HiAmp/HiRep, LoAmp/HiRep, HiAmp/LoRep, and LoAmp/LoRep Groups were fast, medium-fast, medium-slow, and slow, respectively. Movement type group assignment and corresponding rates are depicted in Tables 2 and 3. Since Brand et al. (2002) did not find significant differences in rate of movement in infant- versus adult-directed communication, speed was not a primary parameter of interest in this study. However, should a slow rate influence infant object preference and/or learning, such an effect would be evident in the performance of The LoAmp/LoRep Group.

Table 2. Movement type group assignment by movement parameter

	Amplitude	
Repetition	High	Low
High	HiAmp/HiRep (n = 12)	LoAmp/HiRep (n = 12)
Low	HiAmp/LoRep (n = 12)	LoAmp/LoRep (n = 12)

Table 3. Rate of movement as a function of group assignment

Group	Amplitude	Repetition	Rate
HiAmp/HiRep	High	High	Fast
LoAmp/HiRep	Low	High	Medium-Fast
HiAmp/LoRep	High	Low	Medium-Slow
LoAmp/LoRep	Low	Low	Slow

The Movement Training phase consisted of eight trials, each with a different novel stimulus (see Figure 3). Of these eight stimuli, four had more interesting components, including more color, more detailed shapes, or more complicated textures, than the remaining four stimuli. Order of stimulus presentation was determined prior to testing.

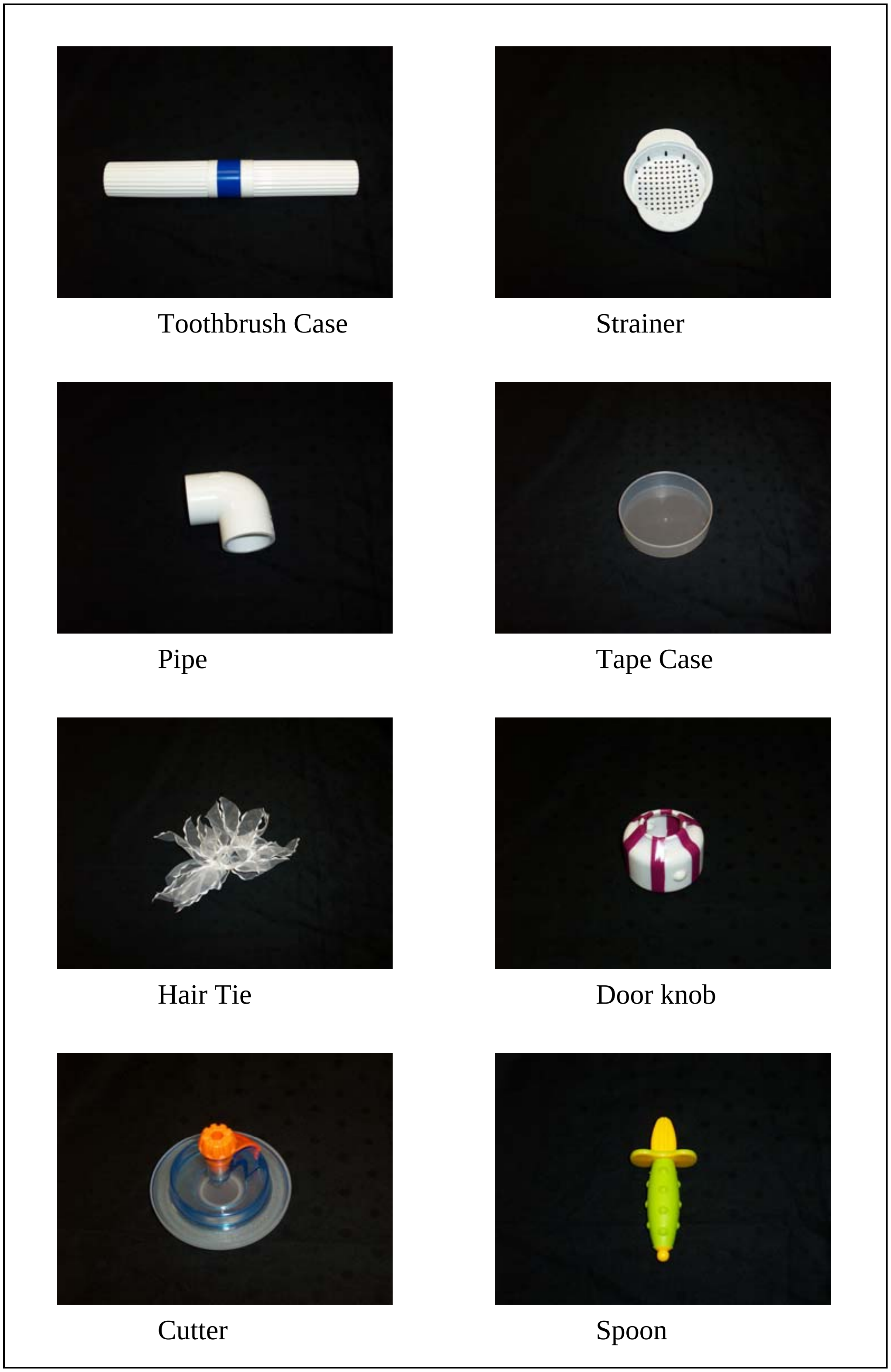

Figure 3. Movement training and test objects

Six different random assignments of stimuli as either target (presented with a target movement) or distracter (held in a static position) were created with the constraint that each stimulus appeared an equal number of times as a target and as a distracter object. Each of these six stimulus presentation orders was used twice in each group, with the stimuli reversing from target to distracter and vice versa in the second use of the order. This resulted in 12 total stimulus presentation orders. Infants in each group were randomly assigned to one of these presentation orders, and the 12 orders were repeated across conditions.

Caregivers were given a set of instructions prior to the beginning of the Movement Training phase, and these were repeated on each trial. First, they were asked to get the infant's attention by calling his/her name. Second, they were asked to mimic exactly the experimenter's movements displayed on the television screen, resulting in a five second demonstration. Third, they were asked to refrain from speaking while copying the movement on the screen to diminish any potentially confounding influence of speech on the trial, but they were encouraged to smile at the infant. After the five second movement display was completed, caregivers were instructed to pass the toy to the infant and to resume normal interaction with the toy for 30 seconds, but to refrain from labeling the stimulus during this time. The target movement was produced with a total of four stimuli on four trials.

The four target trials alternated with four distracter trials. Distracter trials followed the same time sequence as the target trials, with a five second demonstration period during which the caregiver held the stimulus in a static position in front of the infant with no movement. Upon completion of the 5 second display, caregivers then gave the distracter object to the infant for 30 seconds. These trials were identical to the target trials with the exception that the stimulus demonstration involved no movement. This procedure was repeated three times for a total of four displays, one for each distracter object.

2.3.3 Looking time test

The Looking Time Test phase consisted of four trials. On each trial, one of the four target objects and one of the four distracter objects were placed on the two object display cases equidistant from the infant and from the caregiver (see Figure 1). As in previous phases, infants and caregivers sat facing one another. At the start of this phase, the curtains obstructing the stimuli in the object display cases were closed. The curtains were opened when two stimuli were in place, allowing infants but not caregivers to see the stimuli. Caregivers were instructed to say the infant's name, then copy the same target movement displayed in the Movement Training phase from the television screen with an empty hand. As in the Movement Training phase, caregivers were instructed to refrain from speaking during this five second demonstration period. When the target motion was completed, caregivers were instructed to put their hand back down and not interact with the infant for five seconds. This procedure was repeated three more times with the remaining three target and distracter objects for a total of four test trials.

Order of presentation of the target objects was randomly determined; however, this random presentation was repeated for each group. In other words, one infant from each movement group was exposed to the same presentation of stimuli in the Looking Time Test phase. Target objects appeared on either side of the infant equally, alternating for each trial.

2.3.4 Independent play test

The Independent Play Test phase consisted of four trials, each with one target and one distracter object. During this phase, the caregiver's chair was moved away from but still in view of the infant. Caregivers were given a questionnaire to complete during this time to allow infants to play alone. During this phase, the experimenter carried a fabric-covered box, held upside down, to the infant. The box was presented to the infant as a tray with a cover, with one target and one distracter object obscured by the cover. Stimuli were placed in the two front corners of the box relative to the infant, maintaining equal and consistent spacing of target and distracter objects for each trial. The experimenter lifted the cover evenly to ensure simultaneous revelation of the stimuli, and the infant was then allowed to play with the stimuli for 25 seconds. After 25 seconds, the experimenter removed the tray and presented the infant with a new pair of stimuli. This was repeated for a total of four trials, such that all eight stimuli were presented to the infant.

2.4 CODING

Four primary observers who were blind to the study's hypotheses completed the coding for this study. As the primary goal was to investigate infant preference and learning, behaviors of interest included caregiver and infant stimulus touches (for both target and distracter objects), infant looks to caregiver and stimuli, and location of the stimulus. Coders noted the onset and offset of these behaviors in each phase using a time-linked, computer-based video interface system (The Observer Video-Pro, Noldus Information Technologies).

In the Movement Training phase, coders identified the following behaviors: caregiver stimulus touches, caregiver stimulus presentation (whether movement or static), infant looking to caregiver during stimulus presentation, infant target and distracter object touches, and the location of the stimulus when not held in the air (for example, the objects were often placed on the tray of the high chair or dropped on the floor). Codes in the Looking Time Test phase consisted of caregiver movement presentation and infant looks to the target object, distracter object, and caregiver. For the Independent Play Test phase, infant target and distracter object touches were recorded. A detailed description of the coding system appears in the Appendix.

Reliability analyses were completed every 4 weeks, with an average Cohen's Kappa of .80 (*range* = .74 - .86). Disagreements were resolved through discussion, and if a resolution was not reached, the author decided on the appropriate code.

3.0 RESULTS

This study was designed to assess infants' preferences and learning associated with motionese and variation in two parameters of motionese. Of the four target movements, the HiAmp/HiRep movement most closely resembles motionese as defined by Brand et al. (2002). Thus, it was expected that the HiAmp/HiRep movement would have the greatest influence on infant learning and stimulus preference and compared to the LoAmp/HiRep and HiAmp/LoRep movement, which would in turn have a greater impact than the LoAmp/LoRep movement. Alternatively, if a single motionese parameter is effective in influencing infant learning and attention, infants in the HiAmp/LoRep and LoAmp/HiRep groups would be expected to perform like those in the HiAmp/HiRep group; and all three groups should differ from the LoAmp/LoRep group. Following preliminary analyses, data relevant to the three main questions, whether infants prefer action with more parameters of motionese, fewer parameters of motionese, or no movement, whether motionese plays a role in infant learning, and whether motionese leads to stimulus preferences, are presented in turn.

3.1 PRELIMINARY ANALYSES

Three sets of preliminary analyses were conducted for this study, one focusing on infant age, one focusing on potential stimulus preferences, and one focusing on parent demonstration lengths in the Movement Training and Looking Time Test phases.

Potential age effects were examined by dividing infants into three age groups (8 months, 9 months, and 10 months) and examining average touch durations (calculated by dividing the total touch duration by the number of touches) in the Movement Training phase in relation to age. As a group, 9 month old infants touched stimuli overall for shorter intervals (M = 17.817, SD = 8.335) than 8 (M = 26.135, SD = 2.583) and 10 month olds (M = 23.183, SD = 9.796). A 3 (Age) X 2 (Object: Target or Distracter) repeated measures analysis of variance (ANOVA) carried out on these data revealed a marginally significant main effect of Age, $F(2,45) = 2.879$, $p = .067$, with post-hoc pairwise comparisons showing that 9 month old infants tended to touch all stimuli in shorter average intervals than 8 month olds, $p = .063$. Though 9 month olds had a longer average touch duration than 10 month olds, this difference was not statistically reliable, $p = .513$. Neither the main effect of Object nor the Age X Object interaction was significant. As a result, all analyses were performed with data collapsed across infant age. Analyses for the Looking Time Test and the Independent Play Test phases revealed no age differences for average look length or average touch length.

Second, to determine whether infants demonstrated differential preferences for more interesting versus less interesting stimuli, comparisons of infants' average touch durations were conducted. A one-way ANOVA revealed no differences between interesting and uninteresting stimuli, $F(1,191) = 1.071$, $p = .302$. As a result, all subsequent analyses were conducted without regard to stimulus type.

Finally, although caregivers viewed and copied a video of the movement to be demonstrated to infants in the Movement Training and Looking Time Test phases, caregiver demonstration lengths were examined to ensure that demonstrations were of equivalent duration across the four groups. This was done by calculating the duration of the demonstration averaged across trials for each infant and averaging these across infants in each group.

In the Movement Training phase, target demonstration lengths in the HiAmp/LoRep Group were shorter than length of target demonstrations for the HiAmp/HiRep and LoAmp/HiRep Groups, and the LoAmp/LoRep demonstration was shorter than the HiAmp/HiRep Group (HiAmp/HiRep M = 21.307, SD = 2.585; LoAmp/HiRep M = 20.373, SD = 1.541; HiAmp/LoRep M = 15.748, SD = 1.894; LoAmp/LoRep M = 16.050, SD = 3.928); duration of distracter demonstrations were roughly equivalent across groups (HiAmp/HiRep M = 22.486, SD = 2.500; LoAmp/HiRep M = 21.153, SD = 3.845; HiAmp/LoRep M = 19.214, SD = 3.148; LoAmp/LoRep M = 21.765, SD = 6.311). A 4 (Group) X 2 (Demonstration: Target or Distracter) repeated-measures ANOVA carried out on these data revealed a significant main effect of Group, $F(3,44) = 5.582$, $p = .002$, and a significant main effect of Target versus Distracter Demonstration, $F(1,44) = 22.585$, $p = .001$. However, these main effects were qualified by a significant Group by Demonstration interaction, $F(3,44) = 3.796$, $p = .017$. To further identify the source of the interaction, a one-way ANOVA was conducted on target demonstrations alone. This ANOVA indicated that the HiAmp/LoRep and LoAmp/LoRep Groups had significantly shorter target demonstrations than the HiAmp/HiRep Group, and the HiAmp/LoRep Group had a significantly shorter demonstration than the LoAmp/HiRep Group (HiAmp/LoRep v. HiAmp/HiRep, $p = .003$; HiAmp/LoRep v. LoAmp/HiRep, $p = .036$; LoAmp/LoRep v. HiAmp/HiRep, $p = .066$; LoAmp/LoRep v. LoAmp/HiRep, $p = .398$). In light of these differences, data on infant looking during caregiver demonstrations was converted to looking time as a percentage of trial time. As variations in demonstration length did not affect overall trial length (i.e., infants in all groups had the same amount of time to touch stimuli following completion of the demonstration), demonstration length differences did not impact subsequent Movement Training *touch* analyses.

A similar pattern was apparent in the Looking Time Test phase. Caregiver target demonstration lengths (recall that no distracter demonstrations were displayed in this phase) were longer for the HiAmp/HiRep and LoAmp/HiRep Groups (M = 5.862, SD = .955 and M = 5.307, SD = .442, respectively) than the HiAmp/LoRep and LoAmp/LoRep groups (M = 3.647, SD = .735, and M = 3.281, SD = .769, respectively). A one-way ANOVA performed on these data revealed significant group differences in target demonstration length $F(3,44) = 33.709$, p = .001, with post-hoc Tukey tests indicating that the HiAmp/HiRep demonstration was longer than both the HiAmp/LoRep demonstration (p = .001) and the LoAmp/LoRep demonstration (p = .001). In addition, the LoAmp/HiRep demonstration was longer than the demonstration in both the HiAmp/LoRep and LoAmp/LoRep Groups (p = .001 for both comparisons). In light of these differences, data from the Looking Time Test phase will be presented as percentages of trials spent looking at target vs. distracter objects.

3.2 DO INFANTS LOOK LONGER AT ACTION WITH MORE PARAMETERS OF MOTIONESE, ACTION WITH FEWER PARAMETERS OF MOTIONESE, OR NO MOVEMENT?

The first question addressed in this study was whether infants prefer action with more parameters of motionese, action with fewer parameters of motionese, or no movement at all. Specifically, it was hypothesized that infants in the HiAmp/HiRep Group would look longer at the movement demonstration than the LoAmp/HiRep and HiAmp/LoRep Groups, who would in turn look longer at the demonstration than infants in the LoAmp/LoRep Group. Further, infants in all four groups were expected to look longer at the movement demonstration than the static presentation.

This hypothesis was examined using looking time data from the Movement Training phase. In light of the significant differences in demonstration length described above, infant looking times during the demonstration were converted to percent of total demonstration length. This was done by dividing the total amount of time infants spent looking at a demonstration by the total length of the demonstration. These percentages were calculated separately for target and distracter demonstrations and averaged across infants in each group. These data are presented in Figure 4. As is evident, for infants in the HiAmp/HiRep, LoAmp/HiRep, and HiAmp/LoRep Groups the percentage of looking time to the demonstration was greater for target (HiAmp/HiRep M = 98%, SD = 2.923; LoAmp/HiRep M = 97.67%, SD = 3.367; HiAmp/LoRep M = 99.97%, SD = .651) than for distracter demonstrations (HiAmp/HiRep M = 95.417%, SD = 5.195; LoAmp/HiRep M = 93.417%, SD = 7.39; HiAmp/LoRep M = 96.83%, SD = 4.951). In contrast, infants in the LoAmp/LoRep Group had slightly higher proportions of looking time to distracter (97.5%) than to target demonstrations (96%).

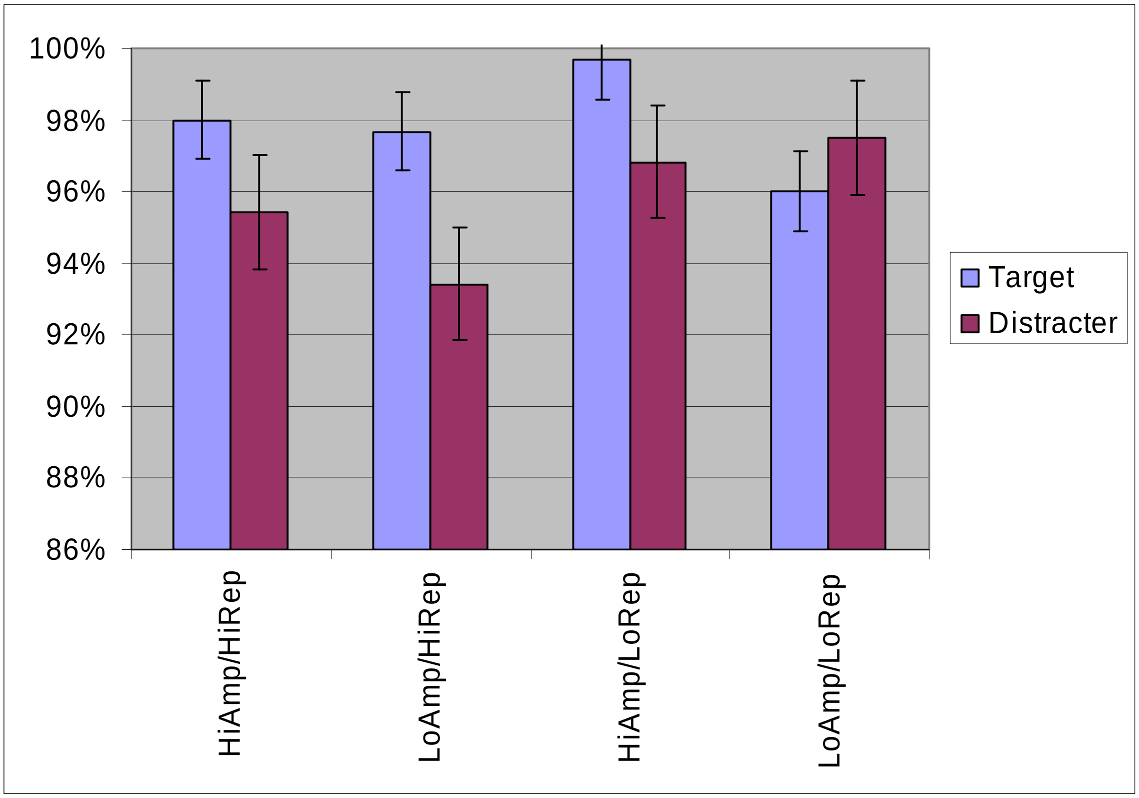

Figure 4. Percentage of trial spent looking at target and distracter movement demonstrations in the Movement Training phase.

These data were arcsine transformed and subjected to a 4 (Group) X 2 (Demonstration: Target or Distracter) repeated measures ANOVA. This analysis revealed a reliable main effect of Demonstration, $F(1,44) = 5.422$, $p = .025$. The main effect of Group was not statistically reliable, $F(3,44) = 1.133$, $p = .346$, but the Group X Demonstration (Target or Distracter) interaction approached significance, $F(3,44) = 1.988$, $p = .130$, suggesting that infants in the HiAmp/HiRep, LoAmp/HiRep, and HiAmp/LoRep Groups tended to look proportionately longer at target than distracter demonstrations, while infants in the LoAmp/LoRep Group tended to look for a greater percentage of time at distracter demonstrations.

3.3 DOES MOTIONESE ASSIST INFANTS IN FORMING ASSOCIATIONS BETWEEN MOVEMENT AND STIMULI?

The next question addressed in this study was whether infants more readily formed associations between stimuli and movements when the movement contained more versus fewer components of motionese. The hypothesis examined here was that infants in the HiAmp/HiRep Group would be more likely to make stimulus-action associations than infants in the LoAmp/HiRep Group or the HiAmp/LoRep Group, and that these three groups would more readily associate actions made with motionese than infants in the LoAmp/LoRep Group. Infant looking time to target and distracter objects in the Looking Time Test phase was assessed to examine this prediction.

Given the previously reported group differences in caregiver target demonstration times, data are presented here as percent of trial spent looking at target versus distracter objects. These were computed by dividing total look lengths (to target or distracter objects) by length of trial. Figure 5 illustrates the percentages of trials spent looking at target vs. distracter objects for each group.

On average, infants in the HiAmp/HiRep Group spent a higher percentage of trial time looking at distracter (M = 20.574, SD = 10.203) than target objects (M = 16.079, SD = 5.140), while infants in the HiAmp/LoRep Group looked at the target object for a higher percent of trial time (M = 18.587, SD = 9.289) than the distracter object (M = 14.136, SD = 3.972). The LoAmp/HiRep and LoAmp/LoRep Groups looked at target (LoAmp/HiRep M = 16.997, SD = 6.99; LoAmp/LoRep M = 17.553, SD = 4.981) and distracter objects for approximately equal percentages of the trials (LoAmp/HiRep M = 16.328, SD = 7.046; LoAmp/LoRep M = 18.012, SD = 6.992).

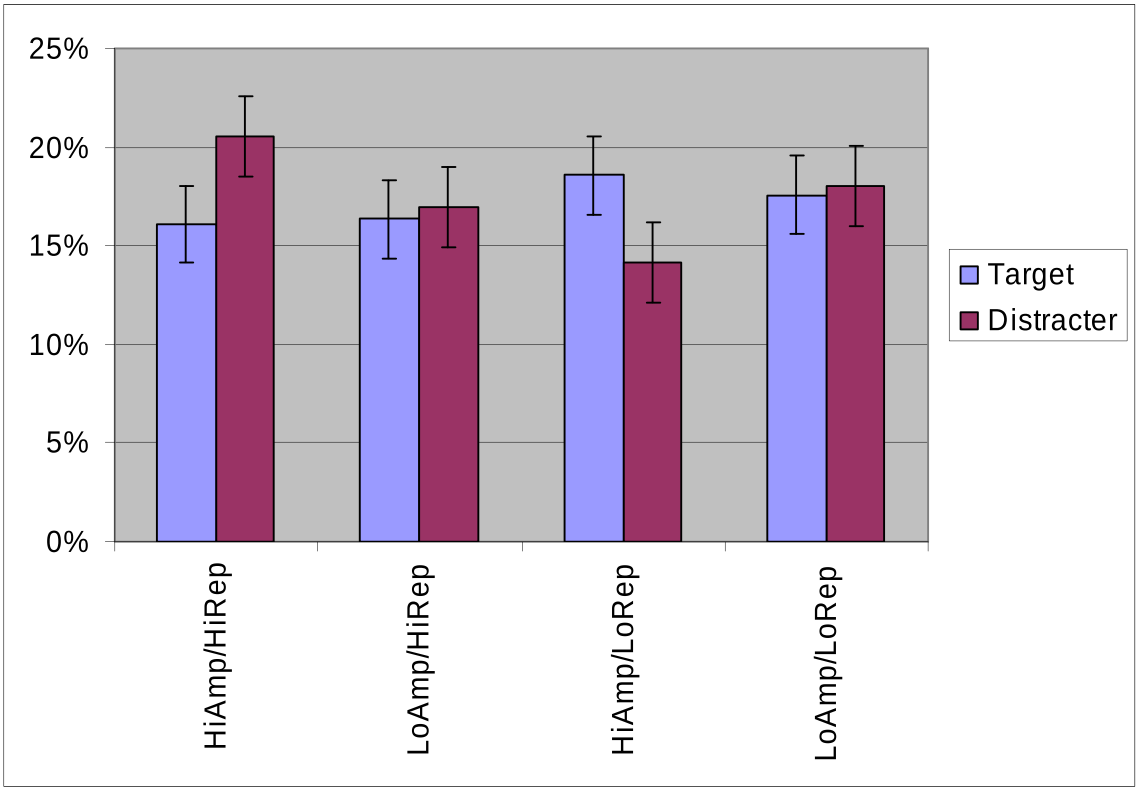

Figure 5. Percentage of trial spent looking at target or distracter objects in the Looking Time Test phase.

A 4 (Group) X 2 (Object) repeated measures ANOVA carried out on these data revealed no main effect of Object, $F(1,44) = .060$, *ns*, or Group, $F(3, 44) = .333$, *ns*. However, the Group X Object interaction approached significance, $F(3,44) = 2.314$, $p = .089$. Simple effects analyses confirmed that infants in the HiAmp/HiRep Group looked for greater percentages of the trial at the distracter as opposed to target object, $p = .122$, and infants in the HiAmp/LoRep group looked for longer percentage of trial at the target object than the distracter object, $p = .126$.

3.4 DOES MOTIONESE HEIGHTEN INFANT ATTENTION TO AND/OR MANIPULATION OF STIMULI?

The final question was whether varying forms of motionese impact infant stimulus preference compared to no movement. As motionese is characterized by high amplitude and heightened repetition, it was hypothesized that stimuli manipulated using high levels of both of these parameters would be most interesting to infants (and thus be manipulated by them for longer periods of time) than stimuli moved using low levels of these parameters. In addition, stimuli that were not moved (i.e., distracter objects) were expected to be of least interest to infants and thus to be manipulated for relatively short periods of time.

Three sets of analyses were conducted to assess this prediction. The first focused on infants' touching of target versus distracter objects during the Movement Training phase. Average touch length for target and distracter objects was calculated by dividing the total touch duration by the number of object touches separately for target and distracter objects for each infant. These data are presented in Figure 6.

As is apparent in the figure, the overall pattern of average touch duration for target vs. distracter objects varied in relation to amplitude. Thus, infants in the two low amplitude groups had longer average touches for target than for distracter objects (LoAmp/HiRep target M = 12.870, SD = 8.544; LoAmp/LoRep target M = 11.702, SD = 5.152; LoAmp/HiRep distracter M = 10.152, SD = 5.801; LoAmp/LoRep distracter M = 9.523, SD = 3.634). In contrast, infants in the two high amplitude groups had longer average touches for distracter than for target objects (HiAmp/HiRep target M = 10.698, SD = 5.176; HiAmp/LoRep target M = 9.671, SD = 5.003; HiAmp/HiRep distracter M = 14.888, SD = 8.535; HiAmp/LoRep distracter M = 11.496, SD = 6.540).

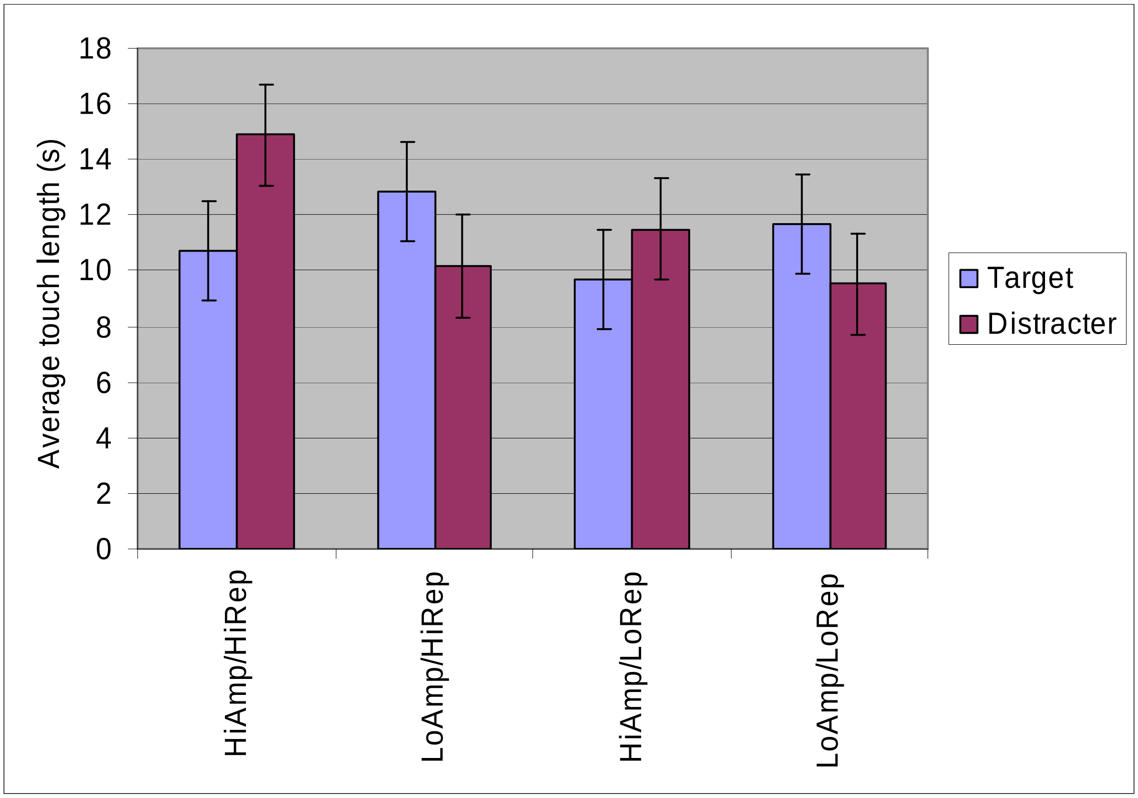

Figure 6. Average target and distracter touch duration during the Movement Training phase.

A 4 (Group) X 2 (Object: Target or Distracter) repeated measures ANOVA revealed no reliable main effects of Group, $F(3,44) = .447$, *ns*, or Object, $F(1,44) = .092$, *ns*. However, the Group X Object interaction was significant, $F(3, 44) = 3.169$, $p = .034$. Simple effects analyses conducted to assess the source of the interaction indicated that both of the groups with low amplitude in the target movement (LoAmp/HiRep and LoAmp/LoRep) had longer average touches of the target object than the distracter object, $p = .065$, but groups with high amplitude (HiAmp/HiRep and HiAmp/LoRep) had longer average touches of the distracter object than the target object, $p = .025$.

The next set of analyses focused on average touch length for target and distracter objects (calculated by dividing the total touch length by the total number of touches separately for target and distracter objects for each infant) during the Independent Play Test phase. As shown in Table 4, there were slight differences in average touch length for target vs. distracter objects for all the groups. However, although the means appear different descriptively, a 4 (Group) X 2 (Object) repeated measures ANOVA carried out on these data confirmed no significant main effects or interactions (ME Group, $F(3,44) = .333$, *ns*; ME Object, $F(1,44) = .094$, *ns*; Object X Group interaction, $F(3,44) = .827$, *ns*).

Table 4. Average target and distracter touch duration during the independent play test **Phase**

Group	Target (*SD*)	Distracter (*SD*)
HiAmp/HiRep	7.518 (3.206)	9.049 (6.588)
LoAmp/HiRep	8.889 (6.343)	7.672 (3.984)
HiAmp/LoRep	6.994 (4.677)	7.692 (3.721)
LoAmp/LoRep	9.864 (4.621)	7.703 (4.613)

The final set of analyses examined latency of stimulus touch immediately after completion of target and distracter movement demonstrations in the Movement Training phase. This measure was created by calculating the amount of time (in seconds) elapsed between the end of the movement demonstration and infants' initial contact with the stimulus. These were averaged across target and distracter trials and then across infants in each group. A 4 (Group) X 2 (Object) repeated measures ANOVA carried out on these data reveled a significant main effect of Object, $F(1,44) = 6.762$, $p = .013$, indicating that initial touches occurred more quickly for distracter objects (*M* = 2.53 seconds, *SD* = 1.26) than for target objects (*M* = 3.31 seconds, *SD* = 1.82). Neither the main effect of Group nor the Object X Group interaction was statistically reliable.

4.0 DISCUSSION

This research was designed to examine a relatively unexplored component of infant-directed communication: infant-directed action, also known as “motionese.” Previous work has indicated that other forms of infant-directed communication are preferred by infants (e.g., infant-directed speech, Cooper et al., 1997; infant-directed sign, Masataka, 1998) and have been tied to infant learning (e.g., infant-directed speech, Fernald et al., 1989; infant-directed gesture, Iverson et al., 1999). This study explored links between varying parameters of motionese on 8 to 10 month old infants’ visual and stimulus preferences and stimulus learning. The study had three primary goals: a) to determine whether infants preferred watching a movement with more parameters of motionese, a movement with fewer parameters of motionese, or no movement at all; b) to examine whether motionese plays a role in infant learning; and c) to explore whether infants prefer stimuli moved with parameters of motionese to stimuli presented in a static fashion.

Results indicated that infants preferred movements incorporating a high level of at least one of the two investigated parameters of motionese. In addition, infants exposed to a specific combination of these parameters (high amplitude and no repetition) associated target stimuli with this movement. Finally, infants exposed to movement displays with a low level of amplitude demonstrated a preference for target objects during independent play. Each of these findings will be considered in turn.

4.1 DO INFANTS PREFER MOTIONESE?

In light of the well-documented finding that infant-directed communication is preferred by infants (e.g., Fernald, 1985; Masataka, 1998), the first question of interest examined in this study was whether infants prefer action with more parameters of motionese, fewer parameters of motionese, or no movement at all. It was expected that infants would prefer a movement with high levels of motionese (e.g., the HiAmp/HiRep movement) to one with fewer parameters of motionese (the LoAmp/HiRep, HiAmp/LoRep, then LoAmp/LoRep movements), and that motionese in general would be preferred to no movement. Results from a comparison of infants exposed to displays with varying parameters of motionese indicated that when infants were presented with high levels of at least one parameter of motionese, they looked longer at the motionese display compared to a display with no movement. However, infants who were exposed to a movement that had low levels of both parameters of motionese (LoAmp/LoRep) looked equally at the movement and a still presentation.

This result underscores similarities between motionese and other forms of infant-directed communication. Specifically, it confirms the existence of parallels between infant-directed speech, sign, and action, as infants prefer all of these forms of communication over forms of adult-directed communication. In addition, given Brand et al.'s (2002) claim that motionese would be preferred by infants to unmodified movement and to no movement, the finding that infants preferred to look at motion as opposed to no motion is not surprising. In fact, infants show preference for motion from as early as 3 months (Morton & Johnson, 1991). However, the present findings contribute to this view by indicating that infants do not simply prefer movement to no movement, as one group of infants (LoAmp/LoRep) did not exhibit this preference. This movement was small, non-repeated, and very slow, and it may therefore have been no more interesting to infants than a static presentation.

4.2 THE ROLE OF MOTIONESE IN INFANT LEARNING

The second question addressed in this study was whether infants exposed to a stimulus moved with motionese would associate that stimulus with the demonstrated action. Some researchers have argued that infant-directed communication is tied to infant learning (e.g., Brand et al., 2002; Fernald, Taeschner, Dunn, & Papousek, 1989; Iverson et al. 1999), and thus it was generally expected that infants would associate stimuli moved with parameters of motionese with the movement. This was expected to vary as a function of infant group, such that infants exposed to the HiAmp/HiRep movement would be most likely to make the association, followed by those in the LoAmp/HiRep and HiAmp/LoRep groups, with LoAmp/LoRep group least likely to give evidence of stimulus-action associations.

Findings yielded partial support for this prediction. Only infants who saw a large, non-repeated movement (HiAmp/LoRep) associated that movement with stimuli that had been moved in that manner. This precise coupling of movement parameters may have resulted in optimal infant attention, which could have assisted the infants' stimulus-action association. It is possible that the movements displayed to the other groups were either too complex, or were not interesting enough, but the height of the movement coupled with the lack of repetition in the HiAmp/LoRep movement appears to play a role in infant stimulus-action associations. Further, 9 month old infants' ability to track vertical movements is much less developed than their ability to track horizontal movements (Grönqvist, Gredebäck, & von Hofsten, 2006), so more effort may be required to track a larger vertical movement. Perhaps the effort involved in tracking this large, non-repeated movement inherently led infants to focus on the stimulus involved in the movement in addition to the movement. This joint interest in both the movement and the stimulus would then lead the infant to associate the stimulus with that movement.

Counter to expectation, infants who were exposed to a movement with a large amplitude and a high level of repetition (HiAmp/HiRep), who were predicted to be the most likely to associate movement with target objects, instead looked reliably longer at distracter objects during movement demonstrations. One possibility is that the movement viewed by the HiAmp/HiRep Group was so attractive and fun that infants did not pay attention to the specific *stimulus* the parent was holding, but rather to the overall *interaction* with the parent. Perhaps looks to distracter objects were longer in this group because infants could clearly see distracter objects during static demonstrations. If this is the case, then they may have remembered distracter objects more readily than target objects.

4.3 THE LINK BETWEEN LOW AMPLITUDE AND STIMULUS PREFERENCE

The final question was whether stimuli manipulated with motionese would lead infants to prefer those stimuli to stimuli presented without movement. Results from the Movement Training phase indicated that low amplitude was associated with infant stimulus preference, as infants in both the LoAmp/HiRep and LoAmp/LoRep Groups touched target objects for longer periods of time. Infants who were exposed to high amplitude levels (HiAmp/HiRep and HiAmp/LoRep) appeared to prefer touching distracter stimuli that had not been moved at all to stimuli that had been moved in a large range, a finding that runs counter to initial prediction.

It may be that movements with high amplitude led infants to be more interested in the interaction with the caregiver rather than the object being presented. Support for this idea comes from two other findings. First, a similar preference pattern did not emerge in the Independent Play Test, suggesting that interaction with the caregiver may have been linked to infant stimulus preference in the Movement Training Phase. If this interaction impacted infant preference, then the removal of the caregiver in the Independent Play Test phase may well result in no stimulus preference. Alternatively, it is possible, at least in principle, that this effect could merely be a result of the time lag between phases. However, by 3 months of age, infants are able to remember specific movements for at least three months (Bahrick & Pickens, 1995); it therefore seems unlikely that that the less than 10 minute time lag between phases can account for this difference.

The notion that interactions with caregivers are more interesting to infants than stimuli is also supported by results from the HiAmp/HiRep Group. Infants in this group did not appear to learn from or prefer objects manipulated with motionese, yet according to the hypotheses of the study, they should have been the most likely to do so. If, however, this form of motionese was very attractive to infants, it may have led them to disregard the objects and focus only on the caregiver. A more fine-grained look at motionese in the context of caregiver-infant interactions may provide further insight into this issue.

Finally, the finding that infants touched distracter objects more quickly than target objects upon completion of the demonstration is not consistent with study hypotheses. However, this may also be a function of caregiver-infant interaction. If motionese was interesting to infants due to the interaction with the caregiver, the shorter latencies for target objects might be explained by infants' hesitance to touch the stimulus in case the caregiver demonstrated the movement again. For static demonstrations, infants would not expect the caregiver to present the stimulus with an attractive movement, and thus touching might occur more quickly.

Joint attention, as the 8 to 10 month age range is a prime time for it emergence (Bakeman & Adamson, 1984), may also have played a role in infants' faster touch latencies for distracter objects. For an infant, a caregiver showing a stimulus in a static presentation could represent an invitation to joint attention, which would then lead the infant to be more interested in the stimulus. If an infant was more interested in the stimulus due to joint attention, it seems reasonable to assume that the infant would be eager to touch and explore the stimulus (Bigelow, MacLean, & Procter, 2004).

4.4 THE IMPORTANCE OF AMPLITUDE

The design of this study made it possible to investigate effects of different combinations of varying movement parameters. Results indicate that high amplitude was linked to infant learning, while low amplitude was related to infant stimulus preference. Specifically, *high* amplitude coupled with low repetition was associated with infants' ability to associate action with stimuli. However, *low* amplitude was associated with infant stimulus preference. As amplitude is a critical component of other areas of infant-directed communication, such as the exaggerated intonation contours present in infant-directed speech (Snow, 1991), it is not surprising that this parameter would be critical to motionese as well.

In contrast, given the presence of redundant information in infant-directed communication (e.g., Gogate & Bahrick, 1998, 2001; Gogate et al., 2000), it was surprising that high repetition in motionese was apparently not as important to infant preferences and learning. The results of this study suggest that the higher levels of repetition may have increased infants' interest in the interaction with the caregiver and decreased their level of interest in the stimulus being presented.

4.5 IMPLICATIONS AND FUTURE DIRECTIONS

The apparent link between motionese and infant preferences and stimulus learning has implications that extend beyond infant-directed action. The results of this study underscore differences between what infants prefer visually, what helps them make associations, and what objects they prefer. This has implications for the controversy surrounding infant-directed speech and learning. If some components of infant-directed action are more helpful for learning, but infants exhibit preferences for others, this may also be the case for infant-directed speech.

In addition, interactions with the caregiver appeared to be quite important to infants in this study. This may be so for other forms of infant-directed communication, and future studies should investigate whether the caregiver-infant interaction in the context of infant-directed speech, sign, and gesture plays a role in infants' preferences and learning.

Further, infant-directed action alone warrants further investigation. As this study was the first of its kind, it investigated only two parameters of motionese. As a result, it would be hasty to generalize the findings presented here to a more global representation of motionese. In order to understand the impact of additional parameters of motionese, future studies should investigate both the remaining 6 defined parameters of motionese (proximity, interactiveness, enthusiasm, rate, simplification, and punctuation, Brand, 2002) and how all 8 parameters together impact infant preference and learning.

One opportunity for further investigation of motionese as documented by Brand et al. (2002) lies in the Warm-Up phase in this study. In this phase, caregivers engaged infants in naturalistic interactions without any advisement from an experimenter; therefore it presents an excellent opportunity to evaluate motionese as it naturally occurs in an interaction. Future investigations of this phase might be more easily generalized to motionese as it was much more natural than the remaining phases in this study. Further, it may also be possible to include evaluations of other components of infant-directed communication, such as infant-directed speech and gesture, and how they, along with motionese, work together to facilitate infant preferences and learning.

In sum, findings from this study suggest that motionese is similar to other components of infant-directed communication. Namely, motionese was tied to infant preferences and learning. However, the way in which motionese impacted infants was not an all-or-nothing phenomenon; though infants did not uniformly prefer or learn from high levels of the two parameters of motionese investigated in this study, variations in motionese did appear to have a nuanced impact on preference and learning. In addition, caregiver-infant interactions appeared to be important, and follow-up studies should address this notion.

APPENDIX

CODING MANUAL

A.1 PHASE

The session is divided into 4 phases: Warm-Up, Movement Training, Looking Time Test, and Independent Play Test.

Each phase begins and ends as follows:

Warm-Up phase: when parent picks up the first toy. The Warm-Up phase is only coded at its start and; there are no other codes entered during the Warm-Up phase.

Movement Training phase: when the first toy is handed from experimenter to caregiver, and the caregiver brings the toy into view (once visible on camera; when object display case is no longer covering the object; if caregiver's hand is in view of the camera when the object is handed to him/her)

Looking Time Test: when the curtains open for the first trial in the first test phase

Independent Play Test: when the experimenter opens the box of toys in the first trial of the second test phase.

A.2 TRIAL

Each phase has codes for trial as follows:

Movement Training: 8 trials
Looking Time Test: 4 trials
Independent Play Test: 4 trials

At the start of a phase, the code for trial should be entered simultaneously. For all phases, note trial end time upon completion. The code for the next trial should begin according to the rules outlined above for phase; e.g. each trial in the Movement Training phase begins once the object is brought into view from behind the display case, except the code is entered at the start of a trial instead of a phase. Also note end time for phases upon completion of the final trial in each phase. The following outlines when end times should be coded for each trial in each phase:

Movement Training: on the exact frame where the infant releases the object to the parent. If the infant is not touching the object, enter trial end time when the parent makes contact with the object to remove it, indicating the trial is over. Note end times for all preexisting behaviors at this time.

Looking Time Test: on the exact frame where the curtains begin to close. Note end times for all preexisting behaviors at this time.

Independent Play Test: when the experimenter walks into view of the camera on screen, from behind the object display case. Note end times for all preexisting behaviors at this time.

A.3 BEHAVIORS

**Codes should be entered if the corresponding behavior lasts for at least .5 seconds. If a behavior lasts for .49 seconds or less, the behavior is not coded.

<u>Objects:</u>

Object codes are entered at the start of each trial in the Movement Training Phase. Use the Object Presentation Order sheet to discern which object is used on which trial.

The Object code should be entered simultaneously with the Trial code for the Movement Training Phase. Note end time for object at the end time for each trial.

Important: Object codes are not used in any other phase.

<u>Parent Codes:</u>

Primary caregiver (a.k.a. "Parent") activity is coded during the Movement Training Phase and Test Phase.

Codes are used to describe when a parent is touching an object, regardless of the object. As caregivers always start a trial by touching an object, always code the parent contact with the object at the start of every trial in the Movement Training Phase. Use this code simultaneously with Trial and Object codes. Note end time when a parent is no longer touching the object. Parents may touch objects at any time during the Movement Training Trials, and these codes should be used whenever a parent touches the object.

Note: A parent and infant may be touching an object at the same time.

When caregivers demonstrate objects to infants, they either hold the objects in a static presentation, a "hold," or they move the object, a "move." This parent activity is also coded. Use the Object Presentation Sheet to tell which trial is a "Move" trial and which trial is a "Hold" trial. Also note end times when parents discontinue their demonstrations.

In the Looking Time Test, parent codes are used as in the Movement Training Phase. The only exception is parents never touch objects, so parent touch codes are never used. Parents complete a specific movement during the Looking Time Test, the same movement they performed in the Movement Training Phase, but with an empty hand. When the parent begins the movement, code that the parent is moving the object. When the movement is complete, note behavior end time as in the Movement Training Phase.

Infant Touch Codes:

Infant Touches are coded when an infant touches an object. There are two types of objects: Target Objects and Distracter Objects. Use the Object Presentation Order sheet to determine which object is a Target (T) or a Distracter (D).

These codes are used in the Movement Training Phase and the Independent Play Test. The touch codes are entered when an infant touches an object in any manner. The exception to this rule is when the infant is hitting the object, much like a "bang." When infants hit an object, make a note of the behavior but do not code it. All other contact should be coded. When an infant is no longer touching an object, note end time.

NOTE: "Target" and "Distracter" are used simply as a way to differentiate between two types of objects. These labels should not influence the way you code in any way, as their meaning is not what it seems.

Location Codes:

These codes are used to describe where an object is located, *if it is not being held in the air by either the parent or the infant*. When the object makes any full contact with the tray, code that contact. The exception to this is when an infant is banging an object on the tray. In this instance, simply make a note of the behavior but do not code it. If an infant or parent drops an object, code that as floor. If a floor code is used, no participant should be touching the object. The final Location Code, other, is used to describe anything other than tray or floor contact. For example, if an infant drops the object into the highchair, use the other code. At times, an object will appear to be both in the other location and on the tray. However, these codes are never entered simultaneously. If an object is on the edge of the tray and tipping at all into the space on the highchair, enter the other code. If the object is perched perfectly horizontally on the edge of the tray and is not tipping into the highchair, the tray code should be used. End time for behaviors should be noted as follows: Floor- as soon as the object is visible on the screen; Other- as soon as the object is again visible on the screen; Tray- as soon as an object is lifted from the tray.

Infant Look Codes:

Look codes are used during the Looking Time Test. At the start of each trial during this test phase, begin coding where an infant looks: to the target object, to the distracter object, or to the parent. Use the object presentation order sheet to determine which side the target or distracter objects are placed. Code all looks in the direction of the objects. Code all looks toward objects unless it is clear that the infant is not looking at the object; i.e. if infants look over their shoulders, to the ceiling, or to the floor, do not code the behavior as a look.

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