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REPORT

Evidence for 'motionese': modifications in mothers' infant-directed action

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Abstract

We investigated the possibility that mothers modify their infant-directed actions in ways that might assist infants' processing of human action. In a between-subjects design, 51 mothers demonstrated the properties of five novel objects either to their infant (age 6–8 months or 11–13 months) or to an adult partner. As predicted, demonstrations to infants were higher in interactiveness, enthusiasm, proximity to partner, range of motion, repetitiveness and simplicity, indicating that mothers indeed modify their infant-directed actions in ways that likely maintain infants' attention and highlight the structure and meaning of action. The findings demonstrate that 'motherese' is broader in scope than previously recognized, including modifications to action as well as language.

As people pursue their goals and intentions in the world, they produce complex streams of motion involving a diverse array of objects. As observers of such everyday action, simply perceiving and identifying the objects involved is a remarkable accomplishment, as is recognizing motion as resulting from an entity's movement independent of ourselves (Palmer, 1999). Yet we readily achieve an analysis of others' actions that goes well beyond such fundamental issues. We detect relevant structure within the flow of motion, note where one action ends and the next begins, and identify the psychological forces motivating the actor's specific patterns of movement. How we achieve all this remains as yet largely unanswered. Any account ultimately offered for these crucial action analysis skills will need to explain, among other things, how infants and young children acquire these skills.

In this article, we consider the possibility that infants receive some assistance from adults as they begin acquiring skills for processing and interpreting complex, everyday action. In particular, we suggest that when interacting with infants, adults modify their movements in ways that simultaneously enhance infants' attention to action[1] and highlight meaningful units within the flow of motion.

Research in the language domain has already targeted an analogous set of issues. Language, like action, is a complex stream of information that does not come presegmented into meaningful units (Hockett, 1947; Myers, Jusczyk, Kemler Nelson, Charles-Luce, Woodward & Hirsh-Pasek, 1996). In everyday speech, words blend seamlessly one into the next, just as in the action domain motions move fluidly from one to another. When interacting with infants, however, adults modify their speech in ways that appear to facilitate infants' meaningful processing of the speech stream (e.g. Fernald, Taeschner, Dunn & Papousek, 1989; Grieser & Kuhl, 1988; Jusczyk, 1997; Morgan & Demuth, 1996; Shatz & Gelman, 1973; Snow & Ferguson, 1977). Recent research has revealed that sign language also contains infant-directed modifications along these lines (Masataka, 1992).

[1] Although it is difficult to precisely define encompassing, everyday terms such as *action*, we use the term here to refer to any voluntary bodily movement (with or without the involvement of objects) not strictly linguistic in nature.

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This special language register is often called 'motherese', although it is characteristic not only of mothers, but of most adults (and even older children) in many cultures (Barton & Tomasello, 1994; Fernald, 1992; Lieven, 1994; Shatz & Gelman, 1973).

We suspect that infant-directed language[2] is just one example of a much broader tendency for adults to introduce modifications in interactions involving infants. For one thing, adults introduce a number of modifications into their language-related *gestures*, indicating some breadth to the motherese phenomenon. Mothers tailor their language-related gestures to infant partners, using fewer gestures over all, and more often using gestures to reinforce or disambiguate the verbal message, rather than to add new information (Bekken, 1989; Iverson, Capirci, Longobardi & Caselli, 1999; Shatz, 1982).

As with infant-directed language, gestural modifications have been studied primarily to investigate implications for infants' language learning. We propose that adults may modify their infant-directed interactions even in completely non-linguistic realms. Such modifications could function to facilitate infants' knowledge acquisition in other domains. In particular, infant-directed modifications introduced into adults' *actions* could provide support for infants' learning about the complex system of intentional human movement. When directing action toward infants, adults may enhance or exaggerate relevant features within the action stream, thereby assisting infants to process action appropriately. If this is correct, mothers should spontaneously display what we might call 'motionese' as part of 'motherese' when interacting with their infants. That is, mothers' infant-directed actions should reveal distinctive characteristics that amplify or exaggerate meaning and structure within their bodily motions. Likewise, these modifications should not be seen in comparable actions directed toward adults. The present study provides the first test of this prediction.

To investigate possible differences between infant- and adult-directed action, we asked mothers of infants to demonstrate the action properties of a series of objects to either their infant or to a well-known adult. However, at no time did we mention to participants our plan to compare infant- versus adult-directed actions. In fact, mothers did not even know that half of those participating in the study demonstrated objects to partners of a different age. These precautions helped to ensure that any infant-directed modifications we discovered would be completely spontaneous.

[2] We use the phrase 'infant-directed language' here rather than the more typical 'infant-directed speech' or 'infant-directed talk' to encompass signed as well as spoken languages.

Although we suspect that motionese may emerge in a variety of action contexts, we chose object demonstrations – actions designed to show another how to interact with an object – as the particular context to target in this study. We felt that this context was a good starting place for several reasons. For one, we wanted to elicit action from mothers that was fundamentally non-linguistic in nature; we were interested in investigating a phenomenon that was distinct from sign-language modifications and distinct from language-related gestures. Secondly, such demonstrations are clearly directed toward a specific partner, making it a likely context in which action modifications linked to the age of the addressee might emerge.

Our participants were mothers who had infants in one of two age-ranges – 6–8 months or 11–13 months – because these ages fall on either side of an important development in the way children attend to objects and other people. Specifically, infants at about 9–10 months first exhibit 'secondary intersubjectivity' (Carpenter, Nagell & Tomasello, 1999; Trevarthen, 1977; Trevarthen & Hubley, 1978); that is, they begin to attend to the relationships between objects and other people, rather than to objects alone or people alone. We suspected changes might occur in the way mothers demonstrate objects to their infants to complement such developmental change in early intersubjectivity.

The objects used in this study were five colorful toys chosen to be novel and interesting to both adult and infant participants. The toys were novel to help encourage balanced content (the 'what' of mothers' object demonstrations) across infant and adult partners. In other words, for adult as well as infant partners, mothers had little or no prior shared knowledge of the objects to rely on, engendering basic similarity in the kinds of actions they demonstrated with the objects. To further ensure comparable content in mothers' demonstrations across partners of different ages, we offered suggestions to mothers about the properties that could be demonstrated for each object. With content controlled to this degree, we were better able to focus on possible stylistic differences (the 'how') in infant- versus adult-directed actions.

Additionally, the interaction was balanced for intimacy, since we suspected that differences in intimacy across conditions might affect the mothers' comfort level, which might in turn influence the affective quality, fluidity or duration of their demonstrations. Accordingly, mothers in both conditions were asked to demonstrate objects to highly familiar partners (their infant versus a spouse, close adult friend or their own mother).

The ideas that guided this research are reminiscent of several lines of work on infant development put forward in past years, but our research represents progress on a number of counts relative to this backdrop. Some years

ago, Stern (1977) discussed intuitions and observations about special behaviors adults exhibit in interaction with infants, including modifications in speech, emotional displays, movements of head and body, and timing. He referred to these modifications as 'infant-elicited social behaviors' and suggested that such modifications would put noteworthy behaviors in 'high relief' against the background of less-relevant displays, thus aiding infants' processing of action. Around the same time, Bruner and his colleagues proposed that adults interact with infants in terms of 'action formats' exhibiting simplified structure (e.g. Ratner & Bruner, 1978; Wood, Bruner & Ross, 1976). However, neither Stern nor Bruner and colleagues documented such action formats as a specialized feature of infant-directed action, as they never directly compared infant- and adult-directed action. Moreover, Bruner and colleagues focused almost exclusively on the possibility that action formats facilitate infants' language acquisition. Our proposal has a distinctly different focus; it targets the possibility that the specialized action adults offer infants might directly assist them in processing and interpreting action itself.

The ideas we present also bear some similarity to Rogoff's (1990) view that children are 'apprentices' to adult thinking. That is, adults and older children lead young children in 'guided participation' by not only demonstrating problem-solving techniques, but by performing activities with or alongside children. According to Rogoff (1990), children benefit from these interactions by learning about the appropriate goals and activities for their society. We propose that in addition, such guided participation might foster infants' understanding about the structure of action itself.

A central question in this research is specifically what kinds of action-modifications we should expect to find when adults interact with infants. Existing findings regarding infant-directed speech and infant-directed sign language provided one useful source of ideas. Infant-directed speech typically includes heightened pitch, broader pitch range, longer pauses, exaggerated pitch excursions (Fernald, 1985; Fernald & Simon, 1984), special placement of new words (Fernald & Mazzie, 1991; Kemler Nelson, Hirsh-Pasek, Jusczyk & Wright Cassidy, 1989; Jusczyk, Hirsh-Pasek, Kemler Nelson, Kennedy, Woodwazd & Piwoz, 1992; Golinkoff & Alioto, 1995; Golinkoff, Hirsh-Pasek & Alioto, 1996) and increased repetition (Jusczyk & Hohne, 1997). Likewise, when adults communicate with infants through sign language, their signing tends to be significantly exaggerated (slower and larger) as well as more repetitive than signing to adults (Masataka, 1992, 1996). These features have the effect of gaining and holding infants' attention (Fernald & Simon, 1984; Masataka, 1992), highlighting new information (Fisher & Tokura, 1995) and marking boundaries between phrase, clause and word units (Kemler Nelson *et al.*, 1989; Jusczyk *et al.*, 1992; Golinkoff & Alioto, 1995; Golinkoff *et al.*, 1996).

Similar kinds of attention-getting and unit-highlighting properties might be present in infant-directed action. As in the language domain, enhancing the relative salience of important action information should augment infants' ability to analyze such action, while drawing attention to boundaries between completed actions should increase infants' ability to segment the stream into relevant units.

In some cases, direct analogs of attention-getting and unit-highlighting characteristics already identified in infant-directed language seemed plausible as components of infant-directed action; at the same time, we also considered dimensions unique to action that might play a similar role. In particular, we reasoned that amplifying action through increased range of motion – on direct analogy to exaggerated pitch excursion – might heighten infants' interest and help to mark the boundaries between action units. Similarly, performing actions in close proximity to infants might serve the same function as the raised pitch of infant-directed speech – that is, to present information in the range for which infant sensory systems are best tuned (Fernald, 1984). Adults might also perform actions more slowly, and with more repetition, when interacting with infants, thereby enhancing infants' familiarity with important units within the motion stream. Additionally, increasing enthusiasm (conveyed via facial expressions and amplified body movements) and interactiveness (seeking eye contact and joint attention, offering objects and touching objects jointly) on adults' part also might serve to enhance infants' attention to action, enabling them to process the motion information more fully. Finally, adults might highlight units for infants by punctuating (introducing more pauses and enacting sharper, more abrupt movements) and simplifying motions (presenting shorter sequences and less complex combinations of actions) in infant-directed relative to adult-directed action. In the present study we focused on these eight features (range of motion, rate, repetitiveness, proximity to partner, enthusiasm, interactiveness, punctuation and simplification) as possible dimensions distinguishing infant-directed from adult-directed action, recognizing that other differences may exist as well.

In addition, we measured how much of the time (a) mothers retained possession of the object, (b) partners were given possession of the object and (c) mother and partner engaged in joint action on the object. It seemed possible that mothers' demonstrations might be longer to infants relative to adults and might include more extended joint action.

Method

Participants

Participants were 51 mothers of infants; 18 mothers participated with their 6- to 8-month-old infants (M = 6;26, SD = 30 days, range = 6.0–8.26) and 16 participated with their 11- to 13-month-old infants (M = 12;10, SD = 28 days, range = 10.24–13.22). The remaining 17 mothers participated with an adult with whom they had a close relationship – either a significant other (13), a close friend (2) or their own mother (2). Of the 17 who participated with an adult partner, six were mothers of a 6- to 8-month-old (M = 7;7, SD = 33 days, range = 6.13–8.28), and 11 were mothers of an 11- to 13-month-old (M = 12;26, SD = 25 days, range = 11.8–14.2). Mothers were recruited from a predominantly Caucasian, middle-class community. All of the infants who participated were full-term and developing normally. Data from an additional 11 mothers were eliminated prior to analyses due to: fussiness of their infant during the session (2); experimenter error or equipment failure (4); and failure to follow directions (e.g. demonstrating more than one object at a time) (5).

Materials

Stimuli

Mothers were asked to demonstrate five novel objects in sequence to their partner: a small circle of red suction cups; a bright green twistable plastic oval tube; a stretchable, rainbow-colored length of wooden beads with wooden knobs at either end; a set of connected clear plastic tubes of various lengths, each containing several colorful wooden balls; and a large clear hamster ball with a smaller colorful bumpy ball to be placed inside it. For each object, a small note card was provided with a description of the object and an explanation of two of the objects' properties. For example, 'The red suction cup "gripper" can attach to the table and makes a popping sound when lifted off.' (See Figure 1 for photos and full descriptions of each object.)

Equipment

Sessions were recorded on a video camera equipped with a stopwatch function and were coded from video using a VCR with frame-by-frame replay capability, yielding continuous information about the temporal flow of events.

Design

The independent variable in this experiment was age of partner: 6–8 months, 11–13 months or adult. We opted for a between-subjects design to avoid possible carryover effects from one partner to another; that is, each mother participated *either* with her child *or* with an adult partner, but not both.

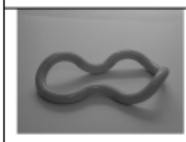
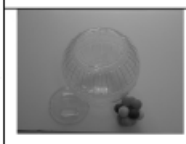
Object	Description Given to Mothers
	The red suction cup 'gripper' can attach to the table and makes a popping sound when lifted off.
	The neon green 'twisty' can be twisted to form different shapes or can be taken apart and put back together.
	The 'rainbow snake' can be stretched and the two rings can slide back and forth from one end to the other.
	The multi-colored 'sci-fi balls' can be turned to allow the balls to fall into other slots, and can also make a rattling sound.
	The colorful 'bumpy ball' can be placed inside the 'hamster ball' and the combination can be rolled around on the table.

Figure 1 *Photos and descriptions of novel objects used in demonstrations.*

Sixteen random orders of the five objects were created such that, within each age group, each mother demonstrated the objects in a different random order. Across age groups, however, the same 16 orders were used. Due to over-scheduling, three additional participants were tested and included in the final sample – two in the 6- to 8-month-old group and one in the 11- to 13-month-old group. Each of these participants duplicated one of the 16 predetermined orders.

Procedure

After a brief warm-up period, mothers were informed that the goal of the study was to investigate how information is communicated during demonstrations of novel objects. To avoid biasing mothers' behavior, we specifically did not mention a comparison between infant- and

adult-directed action. We suggested a loose guideline of one-to-two-minute demonstrations per object, but encouraged mothers to demonstrate the objects however long and in whatever way they felt to be natural.

Mothers were given the opportunity to familiarize themselves with the new objects and their unique properties out of view of the other participant. Participants were then seated at a rectangular table, with mothers always at the head and partners adjacent, so that only the corner of the table separated them. Infants were seated in a high-chair that attached to the tabletop.

The objects were laid out in the predetermined random order on a small, low table that was within the mother's reach but out of the partner's view. Then the experimenter turned on the video camera and left the room until the demonstrations were completed.

Coding and reliability

Our hypothesis in conducting this research was that mothers would introduce modifications in their infant-directed action relative to adult-directed action. In the absence of prior research on this topic, casting a wide net to explore a variety of possible differences at a global level seemed most appropriate. Further, we felt that fruitful investigations of the particular micro-features contributing to broader dimensions would be possible only after the dimensions themselves were identified.

The videotaped experimental sessions were coded on eight broad dimensions. Coders gave each object demonstration a single global rating (0–4) on each dimension. In their instructions, coders were given some hints of specific behaviors to include in their global rating (such as gaze checking, joint attention and frequent exchanges of the object for the variable of *interactiveness*). Dimensions were: *proximity* to partner (0 = 'demonstration always or almost always in the demonstrator's space', 4 = 'demonstration always or almost always in the partner's space', with demonstrator's and partner's space defined by place-mats attached to the table); *interactiveness* (0 = 'very low interaction', 4 = 'very high interaction'); *enthusiasm* (0 = 'very low enthusiasm', 4 = 'very high enthusiasm'[3]); *range of motion* (0 = 'very small, restricted movements', 4 = 'very broad, expansive movements'); *rate* (0 = 'very slow', 4 = 'very fast'); *repetitiveness* (0 = 'no repetitions', 4 = 'extremely repetitive'); *punctuation* (0 = 'gentle, continuous, very fluid actions', 4 = 'sharp, abrupt, very punctuated actions'); and *simplification* (0 = 'complex combinations of many actions', 4 = 'small, simple units of action'). Intermediate scale points were also anchored with verbal descriptions. For the variable of *proximity*, for example, 1 = 'demonstration more often in demonstrator's space', 2 = 'demonstration between demonstrator's and partner's space or equal amounts in both' and 3 = 'demonstration more often in partner's space'. We predicted higher levels of seven of these features (all but rate) in infant-directed than adult-directed action; for rate, we predicted a higher (faster) score for adults than for infants.

All actions the mother performed on the object during the demonstration period were coded for the above eight features, regardless of whether actions were those suggested on the stimulus card, or spontaneous, idiosyncratic actions. Coding of each object demonstration began as soon as the object was brought into view by the mother, and continued until she returned the object to the small table off camera. Within that time frame, there were often stretches of time when the partner was in full control of the object and the mother simply looked on. Of course, during these portions of the interaction – when the mother was no longer in contact with the object – coders could not meaningfully rate the six features specific to mothers' action on the objects (proximity, range of motion, rate, repetitiveness, punctuation and simplification). However, coding of the remaining two variables – enthusiasm toward the object and interactiveness with the partner – continued throughout this portion.

Coders were trained undergraduate research assistants. Characteristics of a given mother's actions were rated with the partner's image obscured, and with the soundtrack turned off. However, because mothers and partners were often engaged in joint action, coders could frequently see the partner's hands. Therefore, accurate coding of the mothers' actions precluded being blind to the age of the partner. In order to safeguard against possible bias in the coding, reliability for each of the coders was checked against a coder who was completely blind to the hypotheses of the experiment. This check, computed on approximately 10% of the final sample, showed satisfactory reliability: Cronbach's alphas ranged from 0.64 to 0.93 for the eight measures.

Finally, additional coders blind to all hypotheses also measured the amount of time each participant was in possession of the object, as well as the amount of time participants were engaged in joint action. For nine of the participants, the angle of the camera made this coding impossible for one or more of the objects demonstrated; data from these participants were removed from analyses of this measure. Inter-coder reliability for this measure was computed on approximately 20% of the final sample; Cronbach's alpha was 0.91.

[3] Coders were instructed to attend only to the enthusiasm shown towards the object. Laughing and smiling that was clearly in regard to something other than the object being demonstrated was discounted.

Results

This research examined whether, given the same objects and instructions, mothers' demonstrations to infants versus adults would differ in ways that might help infants to process the action stream. Before carrying out analyses to investigate this main question, we first examined whether mothers' object demonstrations differed for infants in the two different age groups.

A multivariate contrast comparing the two infant age groups (6–8 months, 11–13 months) across all eight action features (proximity, interactiveness, enthusiasm, range of motion, rate, repetitiveness, punctuation, simplification) and averaging across the five novel objects revealed no significant differences in mothers' demonstrations to the two age groups, Wilks' Lambda = 0.89, $F(8,41) = 0.61$, $p = 0.764$. (The means and standard deviations relevant to this analysis appear in Table 1.) Thus, although there are certainly cognitive and behavioral developments occurring between 8 and 11 months, modifications in mothers' infant-directed actions in this study seemed to be independent of these developments. Given the lack of differences between the two infant age groups, we collapsed across the two groups for the remainder of the analyses.

Table 1 *Characteristics of mothers' demonstrations by age of partner (6–8 months, 11–13 months, adult)*

Action feature	*M*	SD
Proximity to partner		
6–8 months	2.99	0.80
11–13 months	2.85	0.63
Adult	1.11	0.70
Interactiveness		
6–8 months	3.23	0.58
11–13 months	3.18	0.47
Adult	2.22	0.67
Enthusiasm		
6–8 months	2.94	0.64
11–13 months	2.68	0.86
Adult	1.88	0.72
Range of motion		
6–8 months	1.63	0.60
11–13 months	1.64	0.54
Adult	1.00	0.41
Repetitiveness		
6–8 months	2.26	0.75
11–13 months	2.13	0.98
Adult	1.73	0.53
Simplification		
6–8 months	2.13	0.54
11–13 months	2.37	0.54
Adult	1.95	0.40
Punctuation		
6–8 months	2.20	0.89
11–13 months	2.28	0.76
Adult	1.96	0.55
Rate		
6–8 months	2.00	0.63
11–13 months	2.14	0.62
Adult	1.93	0.50

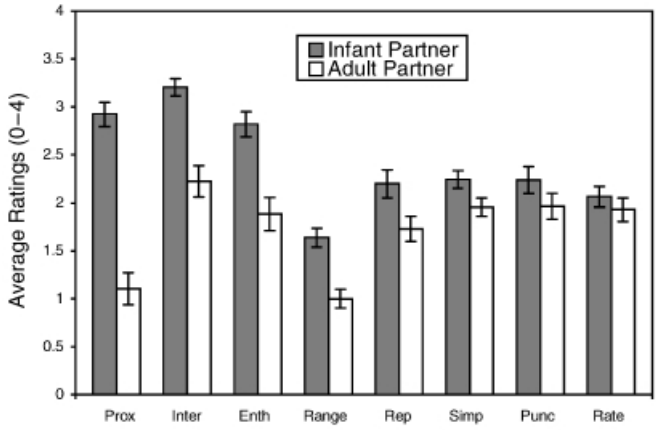


Figure 2 *Characteristics of mothers' demonstrations by condition (infant partner versus adult partner) with standard error bars.*

To address our central query, we performed a multivariate contrast comparing infant- versus adult-directed action across all eight action features, again averaging across the five novel objects.[4] This analysis revealed, as predicted, that mothers significantly modified their actions to infant relative to adult partners, Wilks' Lambda = 0.24, $F(8,41) = 15.82$, $p < 0.001$ (see Figure 2).

To provide more specific information about modifications in mothers' infant-directed demonstrations, we compared infant- versus adult-directed action for each action feature individually. For seven of our eight measures (all but rate), differences were in the predicted direction, which is statistically significant according to a sign test, $p < 0.035$. Furthermore, univariate contrasts comparing infant- versus adult-directed action revealed significant amplification of six of these features (proximity, interactiveness, enthusiasm, range of motion, repetitiveness and simplification), ts(48) > 2.02, ps < 0.05. No significant differences due to partner age emerged for either the punctuation or rate measures. Interestingly, the eight features seemed to cohere as a unitary phenomenon – an inter-item reliability analysis revealed a Cronbach's alpha of 0.77. That is, the modifications associated with infant-directed action were highly intercorrelated.

[4] In order to determine whether the infant-directed/adult-directed differences generalized across the five objects we used, a series of one-way ANOVAs was performed for each of the eight measures with object as the random factor. These analyses yielded the same general pattern of findings that were obtained in the analyses with subjects as the random factor, confirming that the effects generalize across objects of the kind used in this study.

Next, we examined how characteristic motionese was of mothers in our sample. Specifically, how often did mothers in the infant-directed condition exaggerate their action features relative to adult-directed action? To address this question, we first computed a grand average score for each mother across all objects and action features. We then took the median of these scores for each condition (on a scale of 0–4, median of adult-directed action = 1.73, median of infant-directed action = 2.40). The median score in the adult-directed condition provided a comparison score representing 'typical' adult-directed action against which to compare each infant-directed score. We found that 91% of mothers in the infant-directed condition (31/34) had mean scores which exceeded this comparison score, demonstrating that infant-directed action is in fact quite characteristic of mothers in this sample.

Finally, we analyzed the relative amounts of time mothers and partners retained possession of the objects. (The means and standard deviations relevant to this analysis appear in Table 2.) Again, no significant differences emerged between demonstrations to the two infant groups (6–8 months, 11–13 months) for the three object-possession measures (maternal possession time, partner possession time, joint action time), Wilks' Lambda = 0.93, $F(3,37) = 0.99$, $p = 0.407$, so the remaining analyses were performed with the two infant groups collapsed together. Again as predicted, a multivariate contrast revealed significant differences between infant- and adult-directed demonstrations, Wilks' Lambda = 0.50, $F(3,37) = 12.32$, $p < 0.001$.

To further clarify this finding, we used univariate contrasts to examine the pattern of results for the three individual measures. Although one might expect mothers to spend more time demonstrating objects to infants than adults in order to make clear the objects' interesting affordances, we did not find this to be the case. In fact, planned univariate comparisons showed a nonsignificant trend in the opposite direction (mean demonstration time for infants = 42.1 s, mean for adults = 57.1 s, $t(39) = -1.86$, $p = 0.07$). Mothers' somewhat shorter demonstrations to infants may have been driven, at least in part, by infants' impatience to gain possession of the novel objects. In support of this, we found that infant partners maintained possession of the objects significantly longer than adult partners, $t(39) = 4.49$, $p < 0.001$, and, as expected, that mothers engaged in more joint action with infant than adult partners, $t(39) = 4.38$, $p < 0.001$.[5]

Table 2 *Object possession timing (in seconds) by age of partner (6–8 months, 11–13 months, adult)*

Who has possession?	*M*	SD
Mother		
6–8 months	39.35	19.51
11–13 months	45.05	30.40
Adult	57.10	24.07
Partner		
6–8 months	65.09	20.73
11–13 months	54.87	22.75
Adult	27.82	23.13
Joint action		
6–8 months	32.07	15.07
11–13 months	23.94	24.47
Adult	4.81	5.46

Discussion

We asked mothers to demonstrate the properties of novel objects to either their infant or an adult partner, with no mention of any intended comparison of infant- versus adult-directed actions. We found that mothers spontaneously modified their infant-directed actions in a number of ways that might assist infants' learning about action. They demonstrated new objects to infants in closer proximity, with greater enthusiasm, a higher level of interactiveness, greater repetitiveness and movements that were larger in scale but reduced in complexity. As well, mothers devoted more time to joint action on the objects when interacting with infants than adults – they continued to manipulate the toys even after offering them to infants, and often directly assisted infants to act on the toys in effective ways. These infant-directed modifications emerged for infants at both 6–8 months and 11–13 months. Our findings clarify that the phenomenon of 'motherese' – defined as modifications unique to infant- (relative to adult-) directed interactions – extends well beyond the language domain, occurring in action as well.

One might question whether it is safe to characterize motionese as a unitary phenomenon. It is conceivable, for instance, that the dimensions we measured arise independently of one another in infant-directed actions, and thus are not in practice related to one another. Our finding of a high intercorrelation among motionese features suggests otherwise. The characteristics of motionese that we measured tended to cluster together, such that mothers who showed high levels of exaggeration on one dimension tended to show substantial exaggeration on others as well. A typical 'high-motionese' mother would choose a small number of actions to perform on a given

[5] To ensure that variations in the timing variables were not the sole source of differences in infant- versus adult-directed action, we repeated the main analyses controlling for the three timing variables. In the resulting analysis comparing infant- versus adult-directed action across the eight features, the same pattern of findings was obtained as in the original multivariate contrast.

object, and would perform each of these actions several times in succession before proceeding to the next action. Such a mother would often punctuate her actions with attempts to lock gaze with the infant, regularly accompanying such gaze-checks with exaggerated displays of surprise and pleasure.

The present study documents infant-directed action modifications in one particular kind of action context – mothers' demonstrations of novel object properties in face-to-face interaction with infants. We chose this context as a good starting place, but expect that this may be just one of many contexts in which motionese will emerge. To be clear, while object demonstrations were the medium for our current investigation, our broad theoretical question concerns action more generally. Important questions for further investigation are whether adults will display infant-directed action in other kinds of contexts, such as meal-time, or changing clothes, or even beyond to general activities wherein infants are merely observers rather than participants.

Our experimental design and the pattern of our findings help to rule out several possible alternative explanations for the data. First, all of the women who demonstrated objects in both the infant-directed and the adult-directed conditions were in fact mothers of infants. Therefore, it is clear that the action features that emerged in the infant-directed group were not simply a result of one group having more recent experience interacting with infants; rather, they were motion modifications specifically introduced only when infants were the intended audience.

Second, one might point out that infant-directed speech likely accompanied mothers' demonstrations to infants, and for this reason be concerned that such motherese speech was in fact largely responsible for coders' judgments about motion modifications. However, because the sound-track was turned off during coding, infant-directed speech *per se* could not have been the source of coders' judgments.

Third, one might ask whether mothers' demonstrations differed to infants versus adults because they performed entirely different actions to these two groups. We took several steps to ensure that this was not the case. Mothers were given the identical set of objects to demonstrate for both adult and infant partners – objects that were novel to all participants – and guidance about what actions to perform. Thus, mothers were motivated to communicate the same basic informational content regardless of the age of their partner. Despite such balance in the content of demonstrations to infants versus adults, striking differences emerged in the quality of mothers' actions on a number of dimensions.

Finally, one might question whether high levels of motionese features in mothers' infant-directed actions emerged simply as a result of mothers engaging in longer demonstrations with infant than adult partners. This was not the case; in fact, the trend was for mothers' demonstrations to be shorter for infants than for adults.

Two of the dimensions that we measured in mothers' demonstrations – rate and punctuation – did not show significant differences related to age-of-partner. One possible explanation is that our coding system simply was not sensitive enough to pick up on differences along these dimensions that were indeed present in mothers' demonstrations. Perhaps the predicted differences would have emerged if coders judged rate of action and pauses in action at a micro-analytic level, rather than providing a global judgment of rate and punctuation for each object demonstration. On the other hand, if we take the lack of infant-directed modifications on the rate and punctuation dimensions at face value, they are potentially of real interest. In particular, our null findings on these dimensions suggest infants witness action that proceeds in a continuous stream and at a rapid pace, again highlighting the challenge they face in making sense of behavior. In the face of this challenge, the action modifications we did find seem all the more fortuitous for infants.

The current findings raise the question of what mothers' motionese modifications might do for infants. At present, we can of course only speculate, but it seems possible that motionese assists infants' learning about action on many levels, just as infant-directed language appears to promote infants' analysis of language across the gamut of phonology, syntax, semantics and pragmatics. First, motionese likely facilitates infants' attention to action. Such enhanced attention should help infants to learn about action more readily. In our study, mothers' infant-directed action seemed well designed to gain and hold infants' interest in their activities. For example, mothers showed a higher level of enthusiasm and interest in the objects when demonstrating for infants versus adults, used more gaze-checking and joint contact on the object, and held the object closer to the infant partner. Recent research supports the idea that such specialized input in fact elicits greater infant attention. For example, Hains and Muir (1996) have demonstrated that infants recognize and prefer contingent gaze from mothers, suggesting that the increased gaze-checking in mothers' infant-directed action maintains infants' attention. Additionally, Lockman and McHale (1989) found that infants who played with novel objects with their mothers spent more time looking at the objects than infants who played alone. The motion modifications that we have identified may well have been important in driving the effect they observed. In general, if motionese plays the kind of attentional-facilitation role we suggest, then infants should prefer motionese to adult-directed

action, just as they have been shown to prefer infant-directed speech (Fernald, 1985; Fernald & Kuhl, 1987; Werker & McLeod, 1989). Likewise, we would expect motionese to enhance infants' attention to action, *per se*, as well as to the objects involved in such action. Research is under way in our lab to address these important issues.

On a somewhat more specific level, we suspect that motionese helps infants detect structure in action, and derive meaningful units within the motion stream for further analysis. Baldwin and Baird (1999) argue that such 'action parsing' is a necessary first step for infants to construct representations of meaningful action categories and ultimately to infer the intentions motivating action. Modifications in infant-directed action such as repetition, simplicity and interactiveness seem well designed to highlight action units. Performing a given action over and over increases infants' opportunity to recognize that motion sequence as a relevant unit (Avrahami & Kareev, 1994). Likewise, performing simplified pieces of action rather than long, complex action series helps infants to isolate important units. Increased interactiveness leads mothers to offer and retrieve objects more frequently. This has the effect of increasing the initiation and completion of action units, thereby highlighting boundaries between these units in yet another way. If our suspicions here are correct, then infants exposed to motionese for a given action (or class of actions) should show greater sensitivity to the structure within such action than infants who have only encountered the action in adult-directed form. A study investigating this possibility is currently under way.

Infant-directed action may also directly assist infants in gaining access to the meaning of action, by helping them to recognize goals and intentions that motivate action. This could occur because the enhanced levels of enthusiasm and interactiveness that mothers display during infant-directed demonstrations have the effect of amplifying information about intentionality. For example, when demonstrating objects for infants, many mothers in our study produced exaggerated smiles, cheers and gasps of interest when they completed actions that produced interesting effects. These magnified emotions may help infants to recognize goal achievement. Likewise, when mothers fumbled or dropped objects, they often produced pained expressions and exaggerated cries of dismay, which seem to highlight that such consequences were unintended. Altogether, such exaggerated clues to intentionality likely help infants to track mothers' success in pursuing the intentions motivating their actions, and perhaps to understand these intentions in the first place. The presence of amplified intentional cues thus may help to explain infants' early-emerging ability to interpret others' action in intentional terms that researchers have recently documented (e.g. Baldwin, 1991; Carpenter, Akhtar & Tomasello, 1998; Meltzoff, 1995, 1999). Along these lines, recent work by Lillard and colleagues (Lillard, Witherington & Robinette, 2001) suggests that modifications in the action input might help children to identify a particular kind of intention – the intention to pretend. Why is it that children do not seem baffled by the seemingly nonsensical actions adults engage in during pretend play, such as holding a banana to one's ear as if it were a telephone? Perhaps children are able to 'read' the adult's intention to pretend from characteristics of her actions, making children's early facility with pretense less of a puzzle. In sum, if the proposal that motionese facilitates infants' processing of intentions is correct, mothers' rates of the relevant motionese modifications should predict infants' emerging intentional inference skills, in both pretense and reality-based activities.

On the other hand, in suggesting that motionese facilitates infants' learning about action, we are not arguing that motionese plays an *imperative* role. As with infant-directed language, there may well be individual differences in the degree to which adults engage in motionese, but the development of infants' abilities may nevertheless be robust in the face of such variation.

Much remains to be learned about the motionese phenomenon. For one, we do not yet have a fully detailed understanding of the specific nature of motionese modifications. To illustrate, we do not know the precise ways in which mothers inject special enthusiasm into their infant-directed action; we know only in a global sense that they do so. Future work in this area will be charged with the important task of identifying the micro-features that make up the broader dimensions of motionese. Secondly, we do not know who tends to engage in motionese – whether it is limited to Western middle-class mothers, or, like infant-directed language, is characteristic of adults across a variety of cultures, regardless of age, gender or parental status (e.g. Fernald, 1992; Grieser & Kuhl, 1988; Jacobson, Boersma, Fields & Olson, 1983; Shatz & Gelman, 1973). While Lockman (2001) did not specifically compare infant- versus adult-directed action, his finding that siblings as well as mothers seem to tailor their actions to particular objects when interacting with infants provides a first hint that motionese, like infant-directed language, is not limited to mothers.

Finally, we are only beginning to get a glimpse of how motherese, conceptualized in the broad sense to include motion, might shape up. We do not know the extent to which infant-directed action interacts with other infant-directed modifications. How does the entire constellation of features, including such things as gesture

and facial expression, cohere? An important starting place will be to look at the intersection of infant-directed action and infant-directed speech, which could conceivably take many forms. For instance, do adults who display high levels of motherese speech also display high levels of motionese? Alternatively, are they complementary phenomena, such that a given adult will tend to rely on one over the other? One promising avenue of research regarding these issues comes in the shape of Gogate and colleagues' 'multimodal motherese' – the finding that mothers tend to use object gestures in synchrony with novel labels in ways that seem to support infant word-learning (Gogate, Bahrick & Watson, 2000).

Another question that remains is whether the modifications we found are strictly tied to infant-directed interactions. In other words, is there something special about *infants* that motivates this behavior, or is it simply that some characteristics that infants happen to possess elicit this type of motion? To continue the analogy from the language domain, some of the characteristics of infant-directed speech are found in speech to foreigners (Wesche, 1994) and adult lovers or close friends (Trainor, Austin & Desjardins, 2000), suggesting that motherese-type language may be elicited by (a) novice language users, and (b) emotionally intimate companions. Likewise, adults might be expected to show a variant of motionese when language is ineffective (e.g. with speakers of another language) or when the actions and objects involved are highly novel to the partner (e.g. introducing an adult to a keyboard and mouse for the very first time). To sum up, we expect that motionese may be readily elicited by infants, but not necessarily because it is infant-specific. Rather, it may reflect a flexible and functional tendency on adults' part to modify their actions in circumstances where a partner is known to need assistance in knowledge acquisition. We hope that our broad initial finding – the existence of the motionese phenomenon – will inspire future investigation of these and other important questions.

In sum, the present research showcases a phenomenon not previously recognized: when interacting with infants, mothers modify their motions, and these modifications seem well suited to enhancing infants' processing of action. On the one hand, these findings documenting 'motionese' give us reason to conceptualize motherese in broader terms than was previously the case. The findings also impel us to broaden our thinking about the potential richness and value of this scaffolding phenomenon. Motherese – encompassing modifications to motion as well as speech – may well expedite infants' knowledge acquisition across a broad spectrum, and hence serve as an important catalyst for development.

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