

## Word Learning by Eight-Month-Old Infants: The Role of Object Motion and Synchrony

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### Abstract

In this study, 8-month-old infants learned two word-object relations when the hand-held objects were moved in a *Shaking* or *Forward* motion but not in a *Sideways* or *Upward* motion. The results suggest that type of motion is a control parameter for word learning by preverbal infants.

### 1. Introduction

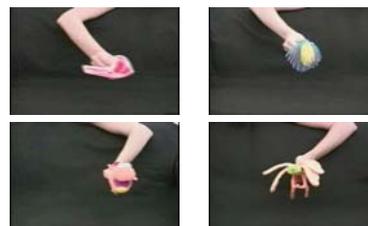
The development of any cognitive milestone (e.g., word learning) is the result of tightly coupled interactions between organism (infant) and environment (Smith, 2005). If this is the case, during the course of word learning we should find *real-time matches* between how infants learn and how caregivers scaffold the environment for their infants. Mothers provide object motion in synchrony with object naming which likely unifies an object and its name for infants (Gogate, Bahrick & Watson, 2000; Zukow-Goldring & Ferko, 1994). Studies of maternal communication to infants have also shown that maternal object naming to infants comprises largely of *showing* gestures consisting of looming or shaking actions (Matatyaho & Gogate, 2008; Zukow & Ferko, 1994). These motions likely capture infant attention by highlighting or foregrounding the object, and likely facilitate learning of word-object relations. In spite of these findings, no controlled experiments to date have focused on the extent to which specific types of object motion facilitate word mapping by preverbal infants. The present study examined whether type of motion mattered during preverbal infants' learning of word-object relations, or whether consistency of motion mattered regardless of type of motion. We hypothesized that if type of motion mattered, then 8-month-old infants should learn word-object relations when shown *Shaking* or *Forward* object motions, but not when shown *Upward*, *Sideways*, or these motions concatenated together (*All-Motion* control condition). Alternatively, if consistency of motion mattered, then infants should learn these relations in the four experimental motion conditions regardless of motion type, but not in the *All-Motion* control condition.

### 2. Method

*Participants.* Sixty full-term, healthy 8-month-old infants (M = 240 days, SD = 10 days) participated with 12 infants in each motion condition.

*Stimuli.* Videotapes of synchronous word-object pairings were created that consisted of two moving toy animal objects, a dragonfly and a fish, and two moving toy non-animal objects, a lamb-chop and a squiggly toy (see Figure 1). Each toy was paired with the words /bæf/ and /wem/, spoken by a female native speaker of English. The words /bæf/ and /wem/ were spoken in synchrony with hand-held object motions under one of four experimental motion conditions – *Forward*, *Upward*, *Shaking*, and *Sideways* – and one *All-Motion* control condition, which had equal distributions of the four motions. Rate of motion and utterance was controlled across conditions. In addition, a videotape of a green and white frog, whose arms spun up and down to make a whirring noise, was used as a measure of alertness and/or fatigue.

Figure 1. The lamb chop, the squiggly toy (above), the fish and the dragonfly (below).

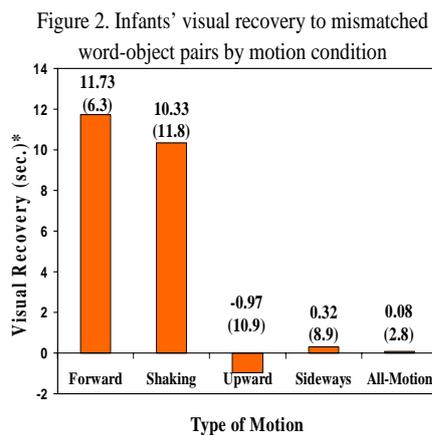


*Infant-Controlled Habituation Procedure.* Infants were randomly assigned to one of the five motion conditions. First, the frog display was shown to direct infants' attention to the monitor during a pretest trial. Following the pre-test trial, infants received habituation trials consisting of alternate presentations of synchronous word-object pairs, until looking declined to a preset criterion. Following the habituation trials, infants were shown two mismatch trials (change) and two control trials (no change)

with order counterbalanced. If infants learned the word-object pairings (e.g., /bæf/-dragonfly, and /wem/-fish) during habituation, interchanging the pairings on the mismatch trials (e.g., /wem/-dragonfly, and /bæf/-fish) should result in longer looking on the mismatch trials relative to the control trials. Finally, infants were, once again, presented with the frog display to measure alertness/fatigue. One or two observers recorded infants' visual fixations to the displays.

### 3. Results

Infants learned the word-object pairings in the *Forward* and *Shaking* motion conditions but not in the *Upward*, *Sideways*, or *All-Motion* conditions. Our index of learning, the visual recovery score (see Figure 2), was calculated by subtracting infants' mean looking on mismatch trials from their mean looking on control trials. An ANOVA of the visual recovery scores by motion condition (5) revealed a significant main effect ( $F [4, 55] = 5.95, p = .0001$ ).



\*Visual recovery is the difference between infants' mean looks to mismatch and mean looks to control trials.

### References

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A paired samples t-test comparing infants' mean looking time to the mismatch versus control trials of each condition further substantiated the results of the ANOVA. Mean looking to the mismatch trials was significantly greater than mean looking to the control trials in the *Forward* and *Shaking* motion conditions, but not in the *Upward*, *Sideways*, and *All-Motion* control conditions.

Secondary analyses revealed no stimulus pair, test order, ethnicity, language, or gender effects -  $ps > .05$ . In addition, ANOVAs conducted to examine whether habituation occurred uniformly across conditions revealed a main effect of the seconds ( $F [4, 55] = 3.506, p = .01$ ), and number of trials ( $F [4, 55] = 2.823, p = .03$ ) it took infants to habituate. Infants showed greater attention (looked longer) during habituation trials in the *Shaking* ( $M = 281.8, SD = 123.9$ ) motion condition than in the remaining four conditions (*Forward* -  $M = 174.2, SD = 86.1$ ; *Upward* -  $M = 170.3, SD = 127.6$ ; *Sideways* -  $M = 153.4, SD = 90.7$ ; and *All-Motion* -  $M = 147.4, SD = 67.7$ ).

### 4. Conclusions

The findings suggest that type of motion matters during word learning. Eight-month-old infants learn word-object relations when words are spoken in synchrony with objects that are shaken or moved forward, but not upwards, or sideways, or if the motions are concatenated together. The present findings, taken together with prior findings of mothers' provision of shaking and forward object motion in synchrony with object naming, demonstrate a *real-time match* between how infants learn and how caregivers scaffold the naming environment for their preverbal infant. In essence, word learning develops as a result of tightly coupled interactions between infant and environment.

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