Intersensory Redundancy Educates Infants' Attention to the Amodal Properties of Speech During Early Development

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Introduction

Research has shown that early in development, information presented redundantly and in temporal synchrony across two or more sense modalities recruits attention and facilitates perceptual learning of amodal properties such as rhythm and tempo more successfully than when the same information is presented to only one sense modality (Bahrick, et al., 2002; Bahrick & Lickliter, 2000, 2002). How then do infants learn to detect amodal properties in nonredundant stimulation? Lickliter, Bahrick, and Markham (2006) found that detection of amodal properties (i.e., rhythm, rate, and duration) in redundant stimulation could educate attention to those same properties in subsequent nonredundant stimulation. Bobwhite quail embryos showed auditory learning of a maternal quail call only when they received redundant audiovisual pre-exposure followed by nonredundant auditory stimulation but not when they received nonredundant (unimodal auditory or asynchronous audiovisual) pre-exposure to the call. The present study extends these findings by investigating whether 3-month-old human infants' attention could be educated to the prosody of speech specifying approval versus prohibition based on amodal properties including rhythm, tempo, duration, and intensity changes. We predicted that if prior exposure to redundant audiovisual stimulation directs infants' attention to amodal properties in subsequent nonredundant auditory stimulation, then infants given redundant audiovisual pre-exposure to the prosodic patterns specifying approval versus prohibition as opposed to nonredundant auditory pre-exposure should discriminate the prosodic patterns during a subsequent nonredundant auditory habituation test session.

Methods

Stimulus Events: The stimulus events consisted of videotaped recordings of two actresses (see Figure 1) reciting two passages (comprised of three phrases each). Passage 1 consisted of "Look at you!" "Come over here by me!" and "Where's the baby going?" Passage 2 consisted of "You did this!" "Gentle with the baby!" and "Whose doggy is that?" Each passage contained approximately the same number of syllables (N = 15, N = 14, respectively). The passages were spoken in infant-directed speech and each passage was spoken in a prosody characteristic of approval and of prohibition. Two versions of each event were created, one for the redundant audiovisual condition and the other for the nonredundant unimodal auditory condition. For the redundant audiovisual condition, the natural synchronous speech was audible and redundancy for prosodic patterns (consisting of rhythm, tempo, duration, and intensity changes) was available across visual and auditory speech. For the nonredudant unimodal auditory condition, the same soundtracks were audible but they were accompanied by a static image of the actress. These unimodal events did not provide redundancy for prosodic patterns.

Procedure: Fifteen 3-month-old human infants were randomly assigned to either receive redundant audiovisual pre-exposure (N=8), or nonredundant auditory pre-exposure (N=7). The pre-exposure phase consisted of four 15-second trials of an actress reciting a passage in an approving or prohibiting manner under the assigned condition. Following the pre-exposure phase, all infants participated in a nonredundant auditory infant-controlled habituation procedure to assess whether the pre-exposure conditions differentially influenced the detection of prosody during subsequent habituation. Infants were habituated to the same auditory event heard during the pre-exposure phase (familiar phrases spoken in familiar prosody) along with the familiar static image of the actress. Following habituation, infants received two post-habituation trials identical to their habituation trials, and then received two nonredundant auditory test trials depicting the familiar phrases spoken in a novel prosody (change from approval to prohibition or vice versa).

Figure 1

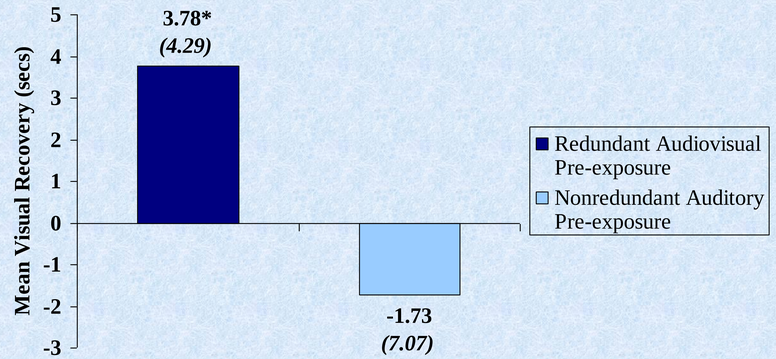
Results

Infants' mean visual recovery (the difference between looking during test versus post-habituation trials) to the novel prosody served as the dependent variable. Preliminary results (Figure 2) indicate that 3-month-old infants were able to discriminate the novel prosody when they received redundant audiovisual pre-exposure followed by a nonredundant auditory habituation session ($t(7)=2.49$, $p=.04$). In contrast, infants were unable to discriminate the novel prosody when they received nonredundant auditory pre-exposure followed by a nonredundant auditory habituation session ($t(6)=-0.65$, $p=.54$).

Conclusions

These results support the hypothesis that detection of amodal properties available in speech such as prosodic patterns (comprised of rhythm, tempo, duration, and intensity changes) in redundant audiovisual stimulation can scaffold or "educate" selective attention to those same stimulus properties in subsequent unimodal stimulation. Taken together with previous studies of animal and human infants (Castellanos, Vaillant-Molina, Lickliter & Bahrick, 2006; Bahrick & Lickliter, 2000, 2002; Lickliter, Bahrick & Honeycutt, 2002, 2004; Lickliter, et al., 2006), these findings underscore the role of intersensory redundancy in recruiting and educating attention to amodal properties during early infancy. Moreover, these results provide one avenue for developmental change from early detection of amodal properties in redundant stimulation to later detection of those same properties in nonredundant stimulation.

Figure 2: Mean Visual Recovery (and SD) to a Novel Prosody Following the Nonredundant Auditory Habituation Task for Infants W



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