Educating Infants' Attention to the Amodal Properties of Speech: The Role of Intersensory Redundancy

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Introduction

According to the Intersensory Redundancy Hypothesis (IRH), in early development, the detection of amodal properties (e.g., rhythm, tempo) is facilitated by synchronous audiovisual stimulation which provides intersensory redundancy (Bahrick & Lickliter, 2000, 2002, 2004). Moreover, synchronous audiovisual stimulation can scaffold or "educate" infants' selective attention to the same stimulus properties in subsequent unimodal auditory stimulation. For example, in our prior studies, 3 ½-month-old infants learned to detect a change in the prosody of speech (comprised of amodal properties such as rhythm, tempo, duration, and intensity changes) in unimodal auditory stimulation, where intersensory redundancy is not available, if they had been pre-exposed to synchronous audiovisual speech but not if they were pre-exposed to unimodal auditory speech.

The present study examined the basis for this finding. Is temporal synchrony between auditory and visual stimulation (i.e., intersensory redundancy) responsible for infants' enhanced detection of prosody in subsequent unimodal auditory stimulation, as predicted by the IRH? Alternatively, perhaps synchronous audiovisual displays provide a greater overall amount of stimulation and/or are more arousing than unimodal displays and this contributes to enhanced detection of prosody? To answer this question, infants in the present study were pre-exposed to asynchronous audiovisual stimulation which offers the same overall amount and type of stimulation as synchronous audiovisual stimulation but eliminates intersensory redundancy. We predicted that asynchronous (nonredundant) pre-exposure would result in decreased discrimination of prosody in subsequent unimodal auditory stimulation as compared with infants from our prior study who received the synchronous audiovisual pre-exposure. If so, then this would support the hypothesis that temporal synchrony between auditory and visual stimulation provides intersensory redundancy and is critical for educating attention to amodal properties, while refuting the "amount of stimulation" hypothesis.

Methods

Stimulus Events: The stimulus events consisted of videotaped recordings of two actresses 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. Videos for the asynchronous pre-exposure phase were edited to depict audiovisual speech, where the dynamic face and the spoken passages were out of synchrony with one another. Videos for the habituation phase were edited to present the actress' soundtrack with a static and affectively neutral image of her face, identical to our prior study.

Procedure: Twenty 3-month-old infants participated. Procedures were identical to those of our prior study. The pre-exposure phase consisted of four 15-second trials of asynchronous speech using approving or prohibiting prosody. Infants then participated in a unimodal auditory infant-controlled habituation phase to assess whether the pre-exposure influenced the detection of prosody during subsequent unimodal auditory stimulation. 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 unimodal auditory test trials depicting the familiar phrases spoken in a novel prosody (change from approval to prohibition or vice versa).

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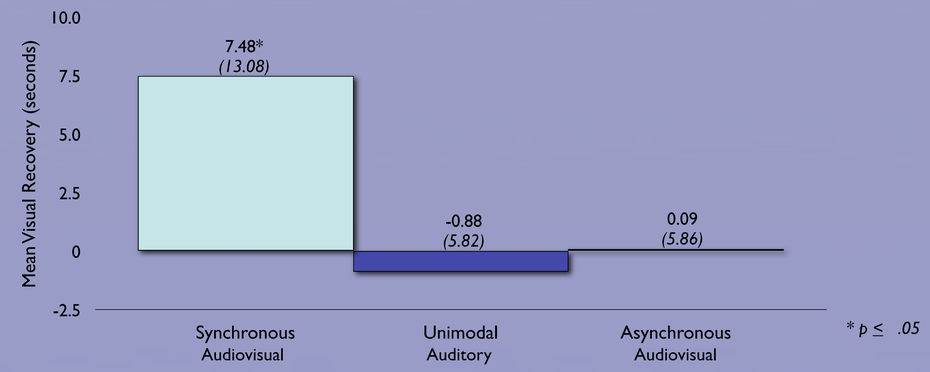
Results

Infants' mean visual recovery to the novel prosody served as our index of discrimination. Results (along with those of our prior study; see Figure 1) support predictions of the IRH and indicate that infants who received asynchronous audiovisual pre-exposure failed to demonstrate significant visual recovery to a change in prosody, $t(19) = .07$, $p = .94$. The performance of infants who received asynchronous audiovisual pre-exposure did not differ from that of infants in our prior study who received unimodal auditory pre-exposure, $t(19) = -0.68$, $p = .51$. In contrast, infants from our prior study who received synchronous audiovisual pre-exposure demonstrated significant visual recovery to a change in prosody, $t(19) = 2.56$, $p = .02$ and their visual recovery was significantly greater than that of infants in both the asynchronous audiovisual pre-exposure condition (present study) $t(38) = -2.31$, $p = .03$, and in the unimodal auditory pre-exposure condition (prior study) $t(38) = 2.61$, $p = .01$. Additionally, infants demonstrated comparable levels of visual interest in the stimulus events across conditions (54.85 seconds (SD = 7.19), 56.20 seconds (SD = 3.54), and 54.73 seconds (SD = 5.75) for the asynchronous, synchronous, and unimodal auditory pre-exposure conditions, respectively).

Figure 1: Mean visual recovery (and SD) to a novel prosody following the unimodal auditory habituation as a function of type of pre-exposure (synchronous audiovisual vs. unimodal auditory vs. asynchronous audiovisual).



Conclusions

The present findings illustrate the critical role of temporal synchrony for educating infants' attention to amodal information such as prosody specifying approval and prohibition in audiovisual speech. Simple co-occurrence of auditory and visual information does not facilitate infants' perception of prosody, proper temporal alignment is necessary. Audiovisual synchrony creates highly salient intersensory redundancy for properties such as rhythm, tempo, and intensity. Together with results of our prior study and those of previous studies of human and non-human animal infants (Castellanos, Vaillant-Molina, Lickliter, & Bahrick, 2006; Bahrick & Lickliter, 2000, 2002, 2004; Lickliter, Bahrick, & Markham, 2006), these findings support the hypothesis that detection of amodal information available in synchronous audiovisual stimulation can scaffold or "educate" selective attention to those same stimulus properties in subsequent unimodal auditory stimulation.

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