Intersensory Redundancy Educates Infants' Attention to the Amodal Property of Tempo

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Introduction

According to the Intersensory Redundancy Hypothesis (IRH), in early development the detection of amodal properties (e.g., tempo) is facilitated by synchronous audiovisual stimulation (intersensory redundancy) and attenuated by unimodal stimulation (Bahrick & Lickliter, 2000, 2002). Moreover, synchronous audiovisual stimulation can scaffold or "educate" selective attention to the same stimulus properties in subsequent unimodal stimulation. For example, in our prior study, 2-month-old infants learned to detect a change in tempo in unimodal visual stimulation, where intersensory redundancy is not available, only if they had been pre-exposed to synchronous audiovisual stimulation, but not if pre-exposed to unimodal visual stimulation (Castellanos, Vaillant-Molina, Lickliter, & Bahrick, 2006).

The present study examined the basis for this finding. Does temporal synchrony between auditory and visual stimulation (intersensory redundancy) educate attention to tempo, and in turn enhance discrimination of tempo in subsequent unimodal stimulation, as predicted by the IRH? Alternatively, might synchronous audiovisual displays simply provide a greater overall amount of stimulation, thereby facilitating enhanced detection of tempo? To distinguish between these alternatives, in the present study 2-month-old infants 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 audiovisual pre-exposure would result in attenuated discrimination of tempo in subsequent unimodal visual stimulation, as compared with synchronous audiovisual pre-exposure in our prior study. If so, this would support the interpretation of our prior study that pre-exposure to intersensory redundancy in the form of audiovisual temporal synchrony served as the basis for educating attention and enhancing discrimination of the amodal property of tempo in the unimodal stimulation that followed.

Method

Twelve 2-month-old human infants participated. Procedures were identical to those of our prior study. The pre-exposure phase consisted of four 15-second trials of asynchronous audiovisual stimulation of films depicting a toy hammer (see Figure 1) tapping at one of two tempos (159 vs 240 bpm). Following the pre-exposure phase, infants participated in a unimodal visual infant-controlled habituation phase to assess whether the asynchronous audiovisual pre-exposure influenced their detection of tempo. Infants were habituated to the hammer tapping silently at the same tempo received during pre-exposure. Following habituation, infants received two unimodal visual test trials depicting the hammer tapping silently at a novel tempo.

Results

Infants' mean visual recovery to the novel tempo served as the index of discrimination. Results, along with those of our prior study (see Figure 2) support predictions of the IRH. They indicate that infants who received asynchronous audiovisual pre-exposure and unimodal visual pre-exposure showed no significant visual recovery to the change in tempo (*p*s> .10), however those who received synchronous audiovisual pre-exposure showed significant visual recovery to the change in tempo ($t(11) = 3.20$, $p = .01$). To compare the performance of infants across conditions, a one-way ANOVA on visual recovery was conducted with pre-exposure condition (synchronous audiovisual, unimodal visual, asynchronous audiovisual) as a between-subjects factor. Results reveal a main effect of pre-exposure condition ($F(2, 30) = 8.50$, $p = .001$). Planned pairwise comparisons indicated that the performance of infants who received unimodal visual and asynchronous audiovisual pre-exposure did not differ from one another ($p > .10$) but both differed significantly from infants who received audiovisual synchronous pre-exposure ($p < .01$; $p < .0005$, respectively). Further, a one-way ANOVA on processing time revealed no main effect of pre-exposure condition ($p > .10$), suggesting that infants of all three pre-exposure conditions displayed comparable levels of overall interest during the unimodal visual habituation session.

Figure 1: Static image of the toy hammer used as the stimulus event.

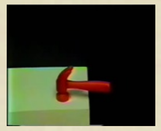
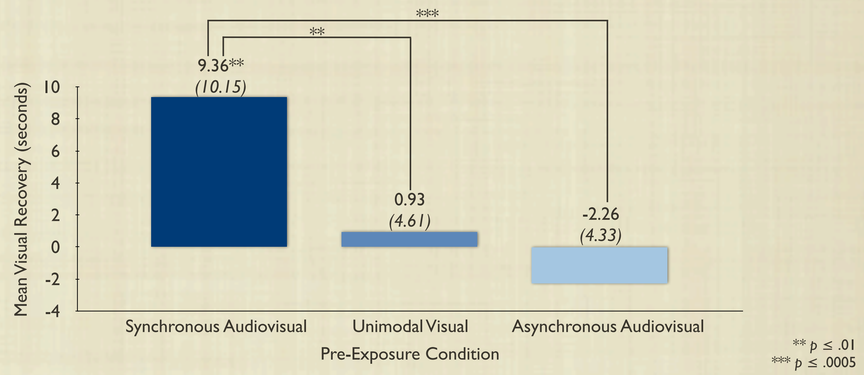


Figure 2: Mean visual recovery *(and SD)* to a novel tempo following unimodal visual habituation as a function of type of pre-exposure (synchronous audiovisual, unimodal visual, asynchronous audiovisual).



Conclusion

The present findings illustrate the central role of temporal synchrony in educating infant attention to amodal properties of events such as tempo of action. The co-occurrence of auditory and visual patterns displaying the same tempo of action facilitates infant perception of tempo only under conditions of synchronous (and not asynchronous) temporal alignment. Intersensory redundancy provided by audiovisual synchrony is highly salient and focuses attention on redundantly specified properties such as tempo, rhythm, and intensity. Together with results 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 the same stimulus properties in subsequent unimodal visual stimulation. This likely promotes attentional flexibility and the developmental shift observed in prior studies (Bahrick & Lickliter, 2004; Flom & Bahrick, 2007), from initial detection of amodal properties in multimodal stimulation to later extension to unimodal stimulation.

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