Intersensory Redundancy Guides Perceptual Learning: Discrimination of Tempo in 3-Month-Olds*

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Abstract

Bahrick and Lickliter (2000) recently proposed an intersensory redundancy hypothesis, which holds that in early development information presented redundantly and in temporal synchrony across two sensory modalities selectively recruits infant attention and facilitates perceptual learning more effectively than does the same information presented unimodally. In support of this hypothesis, we found that 5-month-old infants were able to differentiate between two complex rhythms when they were presented bimodally, but not when presented unimodally. The present study extended our test of the intersensory redundancy hypothesis to younger infants and to the amodal property of tempo. Results replicated and extended those of Bahrick and Lickliter (2000) by documenting that 3-month-old infants can discriminate a change in tempo following bimodal but not unimodal habituation. It appears that when infants are first learning to differentiate an amodal stimulus property, discrimination is facilitated by intersensory redundancy and attenuated under conditions of unimodal stimulation.

Introduction

Research indicates that infants perceive coherent, unified multimodal objects and events through different sensory modalities even in the first months of life. Little is known, however, about how they achieve such impressive intersensory capabilities at such young ages. We have proposed an "intersensory redundancy" hypothesis as an explanation for how this process could be initiated and guided during early infancy. We argue that when information is presented redundantly and in synchrony across sensory modalities it selectively recruits infant attention, causing amodal stimulus properties (such as duration, tempo, rhythm) to become "foreground" and other stimulus properties to become "background". Within a given episode, this leads to earlier perceptual processing for properties that are specified in more than one modality. From this view, infants should more easily detect amodal information when it is presented bimodally that when it is presented unimodally. For example, Bahrick and Lickliter (2000) recently showed that 5-month-old infants could differentiate between two five-element rhythms when the rhythms were presented bimodally, but showed no evidence of differentiating the rhythms when they were presented unimodally. The present experiment was designed to further test the generalizability of this aspect of the intersensory redundancy hypothesis by utilizing younger infants (3-month-olds) and assessing their discrimination of a different amodal property, tempo of action, using the same stimuli and procedures as the previous study. It was hypothesized that infants' detection of tempo would be facilitated under bimodal audio-visual presentations and attenuated under unimodal presentations.

Methods

Thirty-two 3-month-olds were habituated in an infant-controlled procedure to films of a hammer tapping out a rhythmic sequence in one of two tempos (Tempo 1 = 55 bpm, Tempo 2 = 120 bpm). The same tempo could be

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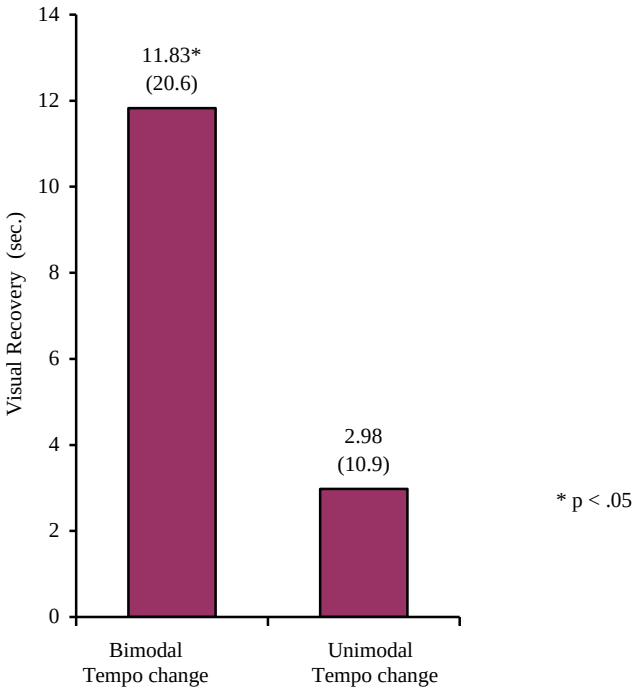
conveyed visually, by watching the hammer and/or acoustically, by listening to its impact sounds. Sixteen infants received bimodal audio-visual habituation to one of the two tempos. Following two no-change post habituation trials, infants received two bimodal test trials depicting a change in tempo. A second group of sixteen infants received unimodal (visual) habituation, two no-change post habituation trials, and two test trials depicting a tempo change. The tempo used for habituation was counterbalanced across infants in each condition.

Results

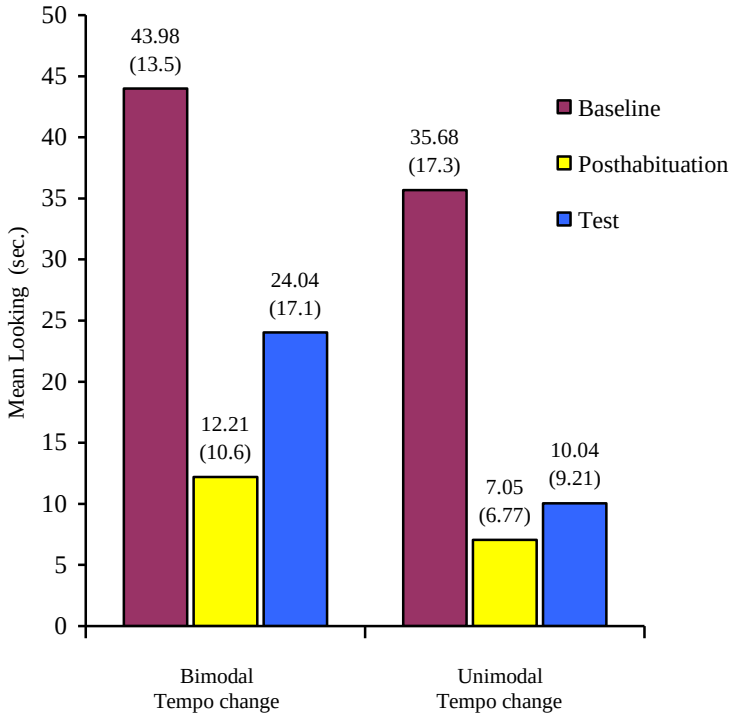
The dependent variable, visual recovery, was computed by subtracting the mean number of seconds looking during the two no-change post habituation trials from the mean number of seconds looking during the two test trials. The results indicate that 3-month-old infants were able to discriminate between the two tempos under conditions of bimodal habituation and testing. Infants receiving redundant (auditory and visual) tempo information during habituation showed significant visual recovery, $t(15) = 2.30$, $p = .036$, to a change in tempo during testing. In contrast, infants who received unimodal exposure to tempo information during habituation failed to show significant visual recovery to the change in tempo, where $t(15) = 1.09$, $p = .289$. These data suggest that infants were unable to discriminate between the two tempos following unimodal exposure. These results are summarized in Figure 1 below.

Figure 1



Further, infants in the bimodal and unimodal conditions did not significantly differ in terms of their duration of baseline looking, $t(15) = 1.8$, $p = .09$, or their duration of no-change post-habituation looking, $t(15) = 1.54$, $p = .145$. These data are summarized in Figure 2.

Figure 2



Conclusion

These findings document that 3-month-olds are able to discriminate between two different tempos when those tempos are presented bimodally, and are not able to discriminate between the two tempos when they are presented unimodally (i.e. visually). The results of this experiment replicate and extend the previous findings of Bahrick and Lickliter (2000) regarding the role of redundancy in guiding attentional selectivity and perceptual learning in early infancy. It appears that when infants first learn to differentiate amodal information, differentiation is facilitated by intersensory redundancy. Bimodal stimulation appears to selectively recruit infant attention to redundant, amodal stimulus properties (such as tempo or rhythm), whereas unimodal stimulation does not. This may promote earlier processing, learning, and memory for stimulus properties specified in more than one modality. These findings are consistent with those from research with animal infants (Honeycutt & Lickliter, in press; Sleigh, Columbus, & Lickliter, 1998) demonstrating the functional distinction between unimodal and bimodal sensory stimulation during the prenatal and early postnatal periods.

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