

**Increasing Specificity in Intermodal Learning: Infant Sensitivity to the Spatial Congruity of  
Audio-Visual Events**

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# Increasing Specificity in Intermodal Learning: Infant Sensitivity to the Spatial Congruity of Audio-Visual Events

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## Abstract

This study investigates the development of infants' sensitivity to amodal temporal relations uniting the sights and sounds of naturalistic events as a function of whether the sights and sounds are spatially colocated versus dislocated. Prior research has demonstrated that young infants are excellent perceivers of amodal temporal information uniting visual and acoustic stimulation when the stimulation is relatively colocated. Further, research has also demonstrated an increasing sensitivity to collocation with age. Our prior research had demonstrated that infants of 2 2-, 3 2-, and 4 2-months learned to relate moving objects and their natural impact sounds on the basis of amodal temporal information when the filmed objects and soundtracks were relatively co-located. In the present study, infants of the same ages were presented with the same habituation and test sequence, however, the images of the objects and their soundtracks were displaced by 90 degrees. Results indicated a significant age by condition interaction. Infants who received colocated films and soundtracks showed evidence of learning the amodal audio-visual relations at all three ages, whereas those who received dislocated films and soundtracks showed evidence of learning amodal temporal relations only at the youngest age. These results show that with development, collocation increasingly constrains intermodal learning about sights and sounds that are temporally related. These findings also support prior research demonstrating an increasing sensitivity to spatial collocation with age and are consistent with our prior findings of a pattern of increasing specificity in infant sensitivity to amodal relations.

## Introduction

Research has demonstrated that infants are excellent perceivers of temporal information uniting sights and sounds in multimodal events. Moreover, infants show perceptual learning on the basis of temporal relations and this learning develops in order of increasing specificity, from global to more specific relations (Bahrack, 1992; 1994; in press). In contrast to the large body of research on infants' sensitivity to temporal information, little research has been conducted on their detection of spatial information uniting sights and sounds. Recent research has, however, found that infants show a developmental trend of increasing reliance on co-location with age. Younger infants associated synchronous objects and sounds despite substantial violations in spatial co-location, whereas older infants did not (Morrongiello, Fenwick, & Nutley, 1998; Fenwick & Morrongiello 1998).

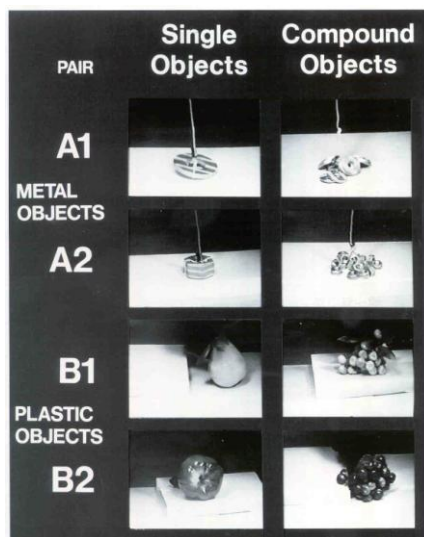
The present study sought to extend our prior work on detection of temporal relations to the domain of spatial relations by investigating the developmental course of infants' sensitivity to spatial co-location during intermodal learning about objects and their natural impact sounds. Our prior research (Bahrack, 1993; 1997) had demonstrated that infants of 2 2-, 3 2-, and 4 2-months learn to relate moving objects and their natural impact sounds on the basis of amodal temporal information (temporal synchrony and temporal microstructure specifying object composition) when the filmed objects and soundtracks were relatively co-located. In the present study, infants of the same ages were presented with the same task, however, the image of the object and its soundtrack were displaced by 90 degrees. This allowed us to further test the general findings of Morrongiello, et. al (1998) using different methods, stimulus events, more extreme violations of co-location, and to assess

intermodal learning of amodal relations rather than arbitrary associations. We hypothesized that younger infants would be better at intermodal learning, given Morrongiello=s findings that sensitivity to spatial information increases with age.

## Method

Infants were habituated to alternating videos of a single, large object producing a single, natural, synchronous impact sound (single object), and a cluster of smaller objects producing a more prolonged, complex, synchronous impact sound (compound object). (The objects are depicted in Figure 1). Control subjects (prior research;  $N = 168$ ) received the soundtracks broadcast from a central speaker located next to the video display, whereas for experimental subjects (present study;  $N = 36$ ) the speaker was located 90 degrees to the left or right of the video display. Following habituation, all infants received two test trials where the films and sounds were mismatched in one of two ways. Half the subjects received films and sounds that were asynchronous. The other half received the wrong sounds in synchrony with the objects. That is, the sounds of the single object were presented in synchrony with the motions of the compound object and vice versa. Visual recovery to the change in object-sound relations was measured to assess whether infants had learned to relate the objects and sounds.

**Figure 1**

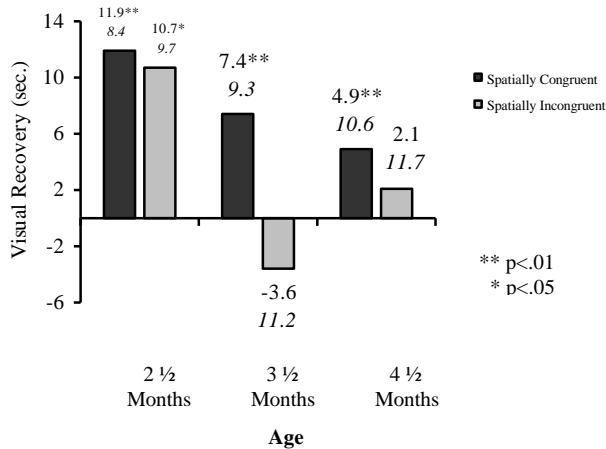


## Results

Results (see Figure 2) indicated a significant age by condition (co-located vs dislocated) interaction ( $F(2,197) = 3.2, p = .041$ ). Control infants who received the co-located information showed significant visual recovery to the changes in object-sound relations at 22-, 32-, and 42-months of age (all  $p$ s  $< .001$ ). In contrast, infants receiving spatially incongruent audio-visual information showed a developmental trend. Infants of 22-months showed significant visual recovery, indicating evidence of intermodal learning ( $t(7) = 3.1, p = .02$ ), whereas infants of 32- and 42-months, did not ( $t(11) = -1.27, p > .1$ ;  $t(15) = .5, p > .1$ , respectively).

## Figure 2

Mean visual recovery (*and SD*) to a change in audio-visual temporal relations as a function of age and spatial congruence



## Conclusions

These results provide converging evidence with findings of Morrongiello, et. al (1998) for a pattern of increasing sensitivity to spatial information across age. Infants of 2 2 months tolerate a relatively large spatial disparity when temporal information unites the visual and acoustic stimulation, whereas older infants require greater spatial congruity to relate sights and sounds. For younger infants, amodal temporal relations appear to play a more important role than spatial co-location in facilitating intermodal learning. Across development, spatial colocation provides increasingly greater constraints on intermodal learning about temporally congruent sights and sounds. These findings are consistent with the pattern of increasing specificity across development found for infant sensitivity to temporal information (Bahrick, 1992; 1994; in press).

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