# INTERSENSORY REDUNDANCY FACILITATES PRENATAL AUDITORY LEARNING IN BOBWHITE QUAIL CHICKS

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**Abstract**

Recent research with human infants has provided evidence that information presented redundantly and in temporal synchrony across two sensory modalities selectively recruits attention and can facilitate perceptual learning in early development. This study examined the role of redundant, bimodally specified information in guiding perceptual learning during the prenatal period by assessing the ability of bobwhite quail embryos to learn an individual maternal call when exposed to (a) unimodal information, (b) concurrent but asynchronous audio-visual information, or (c) redundant, synchronous audio-visual information. The results of this study provide the first evidence that embryos are sensitive to redundant, bimodally specified information and that such information can facilitate perceptual learning in the prenatal period.

**Introduction**

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 attention and facilitates perceptual learning more effectively than does the same information presented unimodally. Results from neuroanatomical, physiological, and behavioral studies of both birds and mammals have provided converging evidence in support of this view, demonstrating the salience of multimodal stimulation for the development of attention and perception during early infancy (Richards, 2000; Sleigh, Columbus, & Lickliter, 1998; Wallace & Stein, 1997). However, the role of intersensory redundancy in guiding attentional selectivity and perceptual learning has not been directly tested in other species or at other stages of development. This study assessed prenatal auditory learning in avian embryos exposed to redundant, synchronous audio/visual information vs. embryos exposed to either asynchronous (auditory and visual) or unimodal (auditory) information during the period prior to hatching. We hypothesized that amodal information presented across two sensory modalities in a temporally coordinated manner would recruit attention and foster perceptual learning, whereas the same information presented unimodally or out of synchrony across two sensory modalities would recruit less attention and lead to attenuated discrimination and learning.

**Methods**

Groups of bobwhite quail embryos were exposed to an individual variant of the bobwhite maternal call for 10 min/hr for a total of 6 hr, 12 hr, or 24 hr prior to hatching. This species-typical call consisted of 5 notes that repeated at a rate of 1.8 notes/sec. One group of embryos (Unimodal Group, Exp. 1) was presented the maternal call without visual

stimulation. A second group of embryos (Asynchronous Group, Exp. 2) was exposed to the maternal call concurrently with visual stimulation (a temporally patterned flashing light) presented out of synchrony with the notes of the call. The third group (Redundant Group, Exp. 3) received the maternal call concurrently with the light temporally synchronized with the notes of the call. These embryos thus received redundant, bimodally specified information about rate and duration across both the auditory and visual modalities in the period prior to hatching.

**Results**

Results of postnatal testing at 24 hr following hatching revealed that only embryos exposed to the redundantly presented auditory and visual information consistently demonstrated prenatal auditory learning. Regardless of whether they received 6 hr, 12 hr, or 24 hr of redundant exposure as embryos, quail neonates significantly preferred the familiar maternal call over an unfamiliar variant of the maternal call in postnatal testing. In contrast, embryos presented the maternal call out of synchrony with concurrent visual stimulation failed to prefer the familiar maternal call following 6 hr, 12 hr, or 24 hr of prenatal exposure. Embryos presented the maternal call without visual information likewise did not prefer the familiar call following 6 hr or 12 hr of exposure, but did show a significant preference in postnatal testing for the familiar call following 24 hr of prenatal exposure (Figures 1, 2, 3). These results provide evidence that intersensory redundancy can guide attentional selectivity and facilitate perceptual learning during the prenatal period. Similar to recent results from human infants (Bahrick & Lickliter, 2000; Gogate & Bahrick, 1998), avian embryos show enhanced perceptual learning when amodal information is presented bimodally and in a temporally coordinated manner.

**Figure 1**

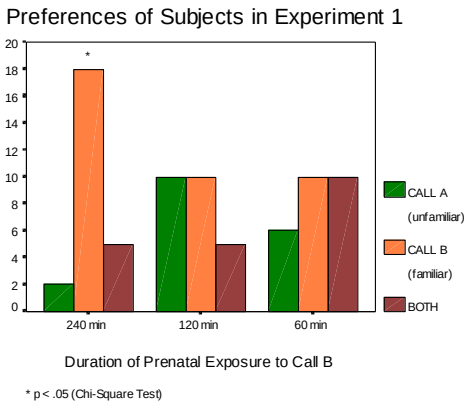



**Figure 2**

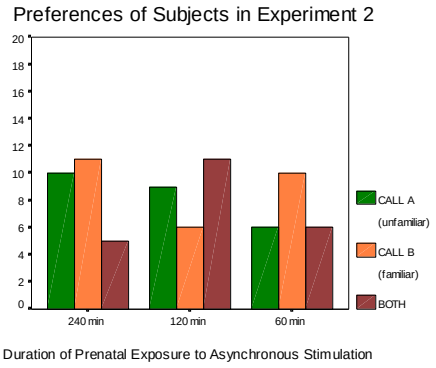
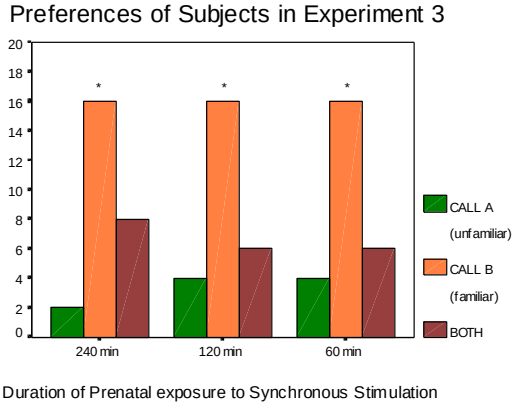



**Figure 3**



## Conclusions

The results of this study provide the first evidence that intersensory redundancy can guide attentional selectivity and facilitate perceptual learning during the prenatal period. This finding further highlights the functional significance of the distinction between multimodal and unimodal stimulation for guiding attention and perceptual learning in early development. Prior findings from avian embryos have suggested that concurrent auditory and visual stimulation interferes with perceptual learning. The present results indicate that it is the lack of redundancy in concurrent bimodal stimulation which disrupts learning in early development. Multimodal stimulation can make overlapping, temporally coordinated information available to the different senses, and this redundancy appears to have a powerful impact on the deployment of attention, even during the prenatal period.

## References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