Selective Attention during Prenatal Development: Redundancy Across Auditory and Vibro-Tactile Stimulation Facilitates Learning in Bobwhite Quail Embryos

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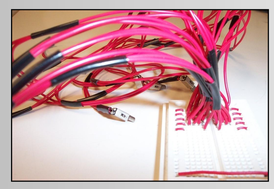
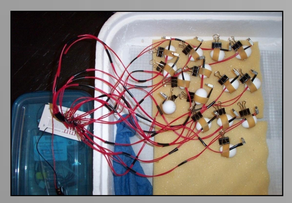
Introduction

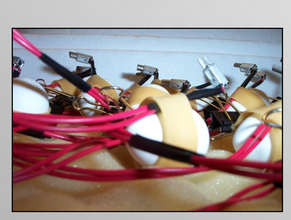
The prenatal environment of birds and mammals provides coordinated multimodal experience, including vestibular, tactile, and auditory stimulation. The Intersensory Redundancy Hypothesis (IRH, Bahrick & Lickliter, 2002) predicts that early in development information presented redundantly (the same information temporally synchronized across two or more senses) recruits selective attention and facilitates learning of amodal stimulus properties (e.g. tempo, rhythm, duration) at the expense of modality-specific properties. Previous studies with bobwhite quail embryos and chicks and human infants have supported this prediction using audio-visual redundancy. If intersensory redundancy generally contributes to enhanced learning during early development, then facilitation should extend to other sensory modalities as well. In the current study, we assessed bobwhite quail's learning of a maternal call under conditions of both unimodal and redundant audio-tactile stimulation.



Methods

Northern bobwhite quail (*Colinus virginianus*) embryos received exposure to an individual bobwhite maternal call in one of two conditions during the day prior to hatching. In the Unimodal Condition, embryos received auditory exposure to a bobwhite maternal call for 10min/hr during the last 12 hours of incubation. In the Audio-Tactile Condition, the same maternal call was paired with a vibro-tactile stimulus synchronized with first note of the 5 note maternal call for 10min/hr during the last 12 hours of incubation.





Vibro-tactile stimulation delivered to the embryos via a wire attached to their egg with rubber bands.

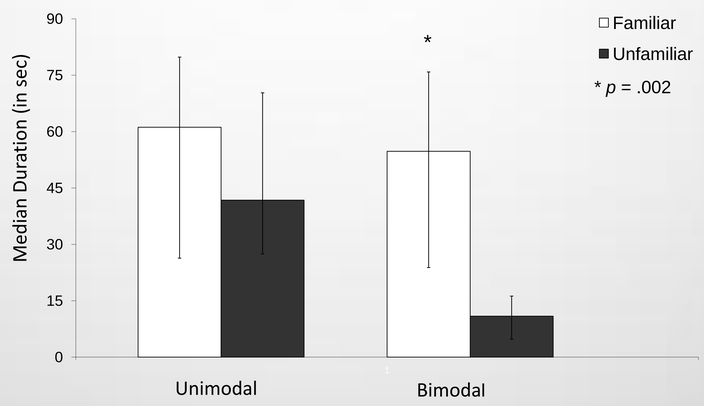
All chicks were tested postnatally at 24 hrs of age in a simultaneous choice test between the familiarized maternal call and an unfamiliar variant of the bobwhite maternal call. During these tests, the two calls were played from opposite sides of a circular testing arena and chicks were scored for their latency and duration for approach to each of the calls. Duration scores for the two calls were converted into proportion of duration (PTD) scores.

Results

• Chicks provided with prenatal unimodal auditory exposure to the maternal call did not prefer the familiarized call over an unfamiliar variant of the maternal call (x^2 = 1.947, p = .378) in postnatal testing.

• In contrast, chicks provided with prenatal auditory/vibro-tactile redundancy (onset synchrony) significantly preferred the familiarized call over the unfamiliar call (x^2 =20.19, < .005) in postnatal testing.

Figure 1: Duration Scores (in sec) for Chicks in Postnatal Testing



• The bimodal group also showed significantly longer duration scores for the familiarized call (Z = -3.037, p = .002), whereas the unimodal group did not show significant differences in their duration of response to the two calls (Z = -.515, p = .607) (Figure 1).

• Chicks that received bimodal exposure also showed significantly greater PTD scores (F(1, 67) = 5.002, p = .029) to the familiar call than did the unimodal group (Figure 2).

Figure 2: Proportion of Total Duration Time for the Familiar Call

Conclusions

• Consistent with the Intersensory Redundancy Hypothesis, our results show that redundant audio-tactile exposure to a maternal call can facilitate prenatal perceptual learning. These findings are consistent with and extend our previous work demonstrating that redundant auditory-visual stimulation can enhance learning and memory in prenatal and early postnatal development (Lickliter et al., 2002, 2004; Jaime et al., 2010). Our results are the first to demonstrate sensitivity to intersensory redundancy across vibro-tactile-auditory stimulation and provide evidence that onset synchrony can facilitate selective attention and perceptual learning during the late stages of prenatal development.

Acknowledgements

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