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Infants Are Not Sensitive to Synaesthetic Cross-Modality Correspondences: A Comment on Walker et al. (2010)

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Werner (1940) believed that we are born with a syncretic unity of the senses and Spector & Maurer (2009) proposed that synaesthesia is characteristic of the neonatal brain because of exuberant anatomical connectivity. This neonatal synaesthesia hypothesis prompted Walker et al. (2010) to investigate whether preverbal infants can perceive pitch-height and pitch-shape synaesthetic-like cross-modal correspondences. They found that when 4-month-old infants heard a sound increasing/decreasing in pitch, they looked longer at a ball moving in a congruent fashion (up/down) than one moving in an incongruent fashion as well as at an object changing its corners in a congruent fashion (rounded/pointy/rounded) than in an incongruent fashion. From this, Walker et al. (2010) concluded that synaesthesia is characteristic of the neonatal brain and that it is an unlearned aspect of human perception. This finding would add to the fact that young infants can perceive various audiovisual relations (Bremner, Lewkowicz, & Spence, 2012; Lewkowicz & Lickliter, 1994), including intensity (Lewkowicz & Turkewitz, 1980), duration (Lewkowicz, 1986), and temporal synchrony (Lewkowicz, 1992, 2010).

Here, we report a failure to replicate Walker et al. (2010) and show that their findings reflect infant response to pitch-loudness interactions rather than synaesthesia. In the Walker et al. study, pitch increased and then decreased between 300 and 1700 Hz while its loudness increased and then decreased between 54 and 80 dB within each phase of the animation, peaking when pitch was midrange (Figure 1a).

The initial increasing pitch/increasing loudness profile of the sound during the congruent animations is perceptually more salient than the initial decreasing pitch/increasing loudness profile of the sound in the incongruent animations. Because of this, the former sound profile may have recruited greater initial attention during a congruent test trial and accounted for the preference for the congruent event. Indeed, findings show that differential initial attentional recruitment affects infant intersensory responsiveness (Lewkowicz, 1992).

Experiment 1 tested the differential attentional salience hypothesis by investigating pitch-height matching across three interleaved congruent and incongruent test trials in separate groups of 4-, 6-, and 8-month-old infants ($N = 23, 23, \& 22$, respectively) with sounds varying in pitch but with reduced accompanying loudness cues. Thus, we only increased loudness from 55.5 to 74.5 dB and only when pitch increased between 300 and 1000 Hz. After that, we maintained loudness at 74.5 dB through 1700 Hz and until pitch decreased back down to 1000 Hz. At this point, as pitch decreased, we decreased loudness back to 55.5

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Author Contributions

D. J. Lewkowicz developed the study concept and study design. Testing and data collection were performed by N. Minar and K. Henning. D. J. Lewkowicz and N. Minar performed the data analysis and interpretation. D. J. Lewkowicz drafted the manuscript and N. Minar provided comments and revisions. Both authors approved the final version of the manuscript for submission.

dB (see Figure 1b). The visual stimulus was a red ball moving up and down at 10 cm/s (with a 50 ms pause at each endpoint) in front of a 20×20 grid of small white dots against a black background on a 19 in screen. Results indicated that infants did not look longer at the congruent event at any age¹. In Experiment 2, we tested pitch-height matching again except that now we varied pitch and visual motion at twice the rate. We tested groups of 4-, 6-, 8-, 10-, and 12-month-old infants ($N = 21, 25, 21, 25, 24$, respectively). Again, results showed that infants did not prefer the congruent event at any age except at six months where infants preferred the incongruent event ($p < .05$).

Experiments 3 and 4 investigated responsiveness to pitch-sharpness with identical testing procedures as in Walker et al. and with similar stimuli (i.e., the earlier-described sound and a star whose corners changed between rounded and sharp). Results from Experiment 3, with separate groups of 4- and 8-month-old infants ($N = 16, 10$, respectively), indicated no preference for the congruent event. Because the infants in Experiment 3 participated in a prior but unrelated experiment, we repeated it with a new cohort of 4-month-old infants ($N=19$) for whom this was their first experiment. The results of this new Experiment 4 again yielded no preference for the congruent event.

Finally, in Experiment 5 we used an intersensory paired-preference procedure to investigate pitch-height matching. Infants saw two identical red balls, moving at the faster rate of Experiment 2, on each of two side-by-side 19 in monitors separated by a 5 in space. Each trial started with one ball at the bottom of the monitor and the other at the top. The balls then moved in silence for 30 s during the first two trials and together with our changing-pitch sound during the second two trials. The results from separate groups of 4-, 6-, 8-, 10-, 12-, & 14-month-old infants ($N = 32, 28, 21, 18, 24, \& 24$, respectively) indicated that infants did not exhibit greater looking at the congruent moving ball in the presence of the sound than in its absence at any age.

In sum, using both same and different methods, and stimuli nearly identical to those used by Walker et al., we found no evidence that infants perceived the link between auditory pitch and visuospatial height or visual sharpness. Importantly, our failure to replicate Walker et al. cannot be due to a lack of statistical power because we tested many more infants and at multiple ages². Thus, it must be due to the reduction of the initial attentional salience of the congruent event. If so, the Walker et al. findings do not reflect infant perception of pitch-height and pitch-shape relations but, rather, interacting pitch and loudness cues. Our failure to replicate Walker et al. suggests that the ability to perceive synaesthetic-like pitch-height and pitch-sharpness relations is not an inherent characteristic of the neonatal brain.

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¹Our ball contacted the monitor edges whereas Walker et al.'s did not. Thus, our infants may have expected an impact and have failed to link the continuous sound with a continuously moving object. This, however, was also true for Walker et al. because Spelke, Born, and Chu (1983) showed that infants expect an impact sound whenever an object reverses its motion trajectory.

²Elimination of data from infants tested at more than one age within a particular experiment yielded identical results as did analyses of log-transformed data.

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Figure 1.
Comparison of the pitch and loudness characteristics of the sliding whistle sound in the Walker et al. (2010) study versus the current one.