**Intersensory Redundancy**

Macey Cartwright, M.A.

Heidi Kloos, PhD

University of Cincinnati

How does redundancy in the input affect the child’s attention? Consider, for example, a scenario in which the child is listening to a parent’s utterances, as well as watching the parent’s lips moving in synchrony with the speech. Intuitively, one might assume that there is an inherent advantage in such informational coherence. The match between sounds and visual input might help constrain attention in productive ways. Alternatively, a mismatch in intersensory information might affects attention negatively. The reality of how intersensory redundancy affects a child’s attention is more surprising than what intuition might suggest, as we discuss in this essay.

Bahrick, Lickliter, and colleagues discovered that intersensory redundancy primes attention to a specific aspect of the information—rather than improving overall attention. Specifically, when the surrounding contains redundant information across senses, a child’s attention focuses on *amodal* content—abstract information that is available across senses in a coordinated fashion. Examples include the tempo or rhythm of a sound, as well as the intensity of an event. In contrast, when there is a mismatch among different aspects of the input, a child’s attention focuses on information that is *modality-specific*—information that is only accessible via one modality (e.g., color for vision; pitch for acoustics).

Two presentation conditions are typically contrasted to demonstrate the effect of intersensory redundancy experimentally: Information is presented either in one modality (e.g., visual input) or in more than one modality (e.g., audio-visual input). For example, a toy hammer is tapped against a surface, either with the tapping sound (multimodal presentation: vision and acoustics) or without it (unimodal presentation: vision only). A crucial test is whether children can attend to a change in information (e.g., a change in the hammer’s orientation; a change in tempo). Findings show that even 3-month-old infants can attend to such changes. Specifically, (1) they were more likely to detect changes in orientation in the unimodal than the multimodal condition; and (2) they were more likely to attend to changes in tempo in the multimodal than the unimodal condition.

The difference in attention to amodal versus modality-specific information was confirmed with 2-month-old infants’ face perception. The task was to discriminate a target face from other faces (all female). The target face was shown as talking either with accompanying audio (multimodal presentation: vision and acoustics) or without (unimodal presentation: vision only). Results confirm an effect of presentation mode: Infants presented with the unimodal clip could successfully discriminated the woman’s face against other women. In contrast, infants presented with the multimodal clip had difficulty with face discrimination. It appears that the unimodal presentation highlighted the modality-specific (visual) content. Interestingly, 3-month-olds can successfully discriminate the woman’s face in both the unimodal and the multimodal conditions.

On the basis of these findings, the so-called *intersensory redundancy hypothesis* (IRH) was proposed. It states that redundant information primes a child’s perceptual system to selectively attend to and learn about amodal properties. Vice versa, unimodal information primes the perceptual system to selectively attend to and learn about modality-specific properties. These principles are said to be most evident when attentional resources are limited (e.g., early in development). As children grow older and gain more experience, their attentional abilities mature enough to attend to both amodal and modality-specific information, independent of presentation mode. And as task difficulty increases, the dissociation between presentation modes re-appears.

The link between intersensory redundancy and children’s attention offers important insights about the developing mind. First, it highlights the fluidity of attention: Intersensory redundancy guides children’s attention differently than unimodal information. Such fluidity is present early on in infancy, allowing the baby to learn from her surrounding, whether information is synchronized across different senses or whether it is unique to a specific modality. Thus, babies benefit from input in complex ways, affected by the degree to which different aspects of information are synchronized.

Second, the effect of intersensory redundancy shows that even young children can attend to abstract content. This content becomes available automatically under the right circumstances, without requiring a laborious mental integration. This puts to rest the controversy about whether multisensory integration is (1) a protracted matching process that builds upon unimodal perception, or (2) an automatic process that precedes the differentiation into unimodal perception. The answer lies in whether the different modalities are redundant or not.

Ultimately, the effect of intersensory redundancy highlights the resourcefulness of the developing mind, namely to assign more than one meaning to the exact same input. It can make sense of the multiple layers of information merely through the interplay of mental biases and how information is structured.

**Further Readings**

Bahrick, L. E., & Lickliter, R. (2002). Intersensory redundancy guides early perceptual and cognitive development. *Advances in child development and behavior, 30*, 153-189.

Bahrick, L. E., & Lickliter, R. (2004). Infants’ perception of rhythm and tempo in unimodal and multimodal stimulation: A developmental test of the intersensory redundancy hypothesis. *Cognitive, Affective, & Behavioral Neuroscience, 4*(2), 137-147.

Bahrick, L. E., & Lickliter, R. (2012). The role of intersensory redundancy in early perceptual, cognitive, and social development. In A. J. Bremner, D. J. Lewkowicz, & C. Spence (Eds.). *Multisensory development*. Oxford University Press. pp. 183-206.

Bahrick, L. E., Flom, R., & Lickliter, R. (2002). Intersensory redundancy facilitates discrimination of tempo in 3‐month‐old infants. *Developmental psychobiology, 41*(4), 352-363.

Bahrick, L. E., Krogh-Jespersen, S., Argumosa, M. A., & Lopez, H. (2014). Intersensory redundancy hinders face discrimination in preschool children: Evidence for visual facilitation. *Developmental psychology, 50*(2), 414.

Bahrick, L. E., Lickliter, R., & Castellanos, I. (2013). The development of face perception in infancy: Intersensory interference and unimodal visual facilitation. *Developmental psychology, 49*(10), 1919.

Bahrick, L. E., Lickliter, R., & Flom, R. (2006). Up versus down: the role of intersensory redundancy in the development of infants' sensitivity to the orientation of moving objects. *Infancy*, *9*(1), 73-96.

Bahrick, L. E., Lickliter, R., Castellanos, I., & Vaillant‐Molina, M. (2010). Increasing task difficulty enhances effects of intersensory redundancy: Testing a new prediction of the intersensory redundancy hypothesis. *Developmental science, 13*(5), 731-737.

Gogate, L. J., & Bahrick, L. E. (1998). Intersensory redundancy facilitates learning of arbitrary relations between vowel sounds and objects in seven-month-old infants. *Journal of experimental child psychology, 69*(2), 133-149.

Hillairet de Boisferon, A., Dupierrix, E., Quinn, P. C., Lœvenbruck, H., Lewkowicz, D. J., Lee, K., & Pascalis, O. (2015). Perception of Multisensory Gender Coherence in 6‐and 9‐Month‐Old Infants. *Infancy, 20*(6), 661-674.

Lewkowicz, D. J., Minar, N. J., Tift, A. H., & Brandon, M. (2015). Perception of the multisensory coherence of fluent audiovisual speech in infancy: Its emergence and the role of experience*. Journal of experimental child psychology, 130*, 147-162.

Minar, N. J., & Lewkowicz, D. J. (2017). Overcoming the other‐race effect in infancy with multisensory redundancy: 10–12‐month‐olds discriminate dynamic other‐race faces producing speech. *Developmental science.* doi: 10.1111/desc.12604

Murray, M. M., Lewkowicz, D. J., Amedi, A., & Wallace, M. T. (2016). Multisensory processes: a balancing act across the lifespan*. Trends in neurosciences, 39*(8), 567-579.

Thomas, R. L., Misra, R., Akkunt, E., Ho, C., Spence, C., & Bremner, A. J. (2017). Sensitivity to auditory‐tactile colocation in early infancy. *Developmental science.*