Auditory and Visual Continuity Perception: A Unifying Theory

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Introduction

Researchers in the field of auditory and visual perception have been intrigued by our ability to unify partially occluded objects (Shipley & Kellman, 1992; Kellman & Shipley, 1991) and partially masked sounds (Dannenbring, 1976; Ciocca & Bregman, 1987). In vision, an object may be partially occluded by another object yet we may perceive the object as continuing behind the occluder. In audition, sounds may be partially masked by another sound, yet we may hear the sound as continuing through the mask. Though these phenomena are considered to be analogous (Bregman, 1990), separate theories exist to predict the conditions under which continuity perception occurs in vision (Relatability Theory - Kellman & Shipley, 1991) and audition (Frequency Proximity and Trajectory principle - Ciocca & Bregman, 1987). The purpose of this paper is to propose that the conditions under which continuity perception occurs for edges and tones may be predicted by one theory. This theory, introduced here and inspired by Relatability Theory, is called "Continuity Theory Audio-Visual (AV)."

Continuity Theory (AV)

Continuity Theory (AV) predicts that a partially occluded stimulus will be perceived as continuing behind an obstruction if the linear extensions of the stimulus on either side of the obstruction meet within the bounds of the obstruction. For the visual domain, this means that an edge partially covered by an occluder will be perceived as continuing behind the occluder if the linear extensions of the edges meet within the area occupied by the occluder. For the auditory domain, this means that a tone partially masked by a noise burst will be perceived as continuing through the noise burst if the linear extensions of the pre and post-noise frequencies meet within the duration of the mask.

Evidence that Continuity Theory (AV) can predict the conditions under which edges and tones are perceived as continuous is provided through a critical analysis of the results obtained in two studies – Shipley & Kellman (1992) on unit formation in vision and Ciocca & Bregman (1987) on perception of tones through noise. In Shipley & Kellman (1992) participants perceived partially occluded figures as unified if the linear extensions of their edges met within the bounds of relatability (see Kellman & Shipley, 1991 for details). In Ciocca & Bregman (1987) listeners perceived sounds as continuing through a burst of noise depending on the frequency and trajectory (i.e. linear extension) of the pre and post-noise tones. Close examination of the results from these two studies reveals that one theory is sufficient to describe the conditions under which continuity perception occurred. This theory is Continuity Theory (AV). The advantage of the theory is it can account for the results obtained in vision and audition. In addition, the theory includes size/duration of the occluder/mask as a factor in unit formation, a variable not incorporated in other theories of continuity (Kellman & Shipley, 1992; Ciocca & Bregman, 1987) yet considered to be important in continuity perception (Vicario, 1982).

Future Directions

In summary, Continuity Theory (AV) provides a simple and general cross-modal rule that predicts continuity perception for those conditions tested in Shipley & Kellman (1992) and Ciocca & Bregman (1987). Future work should involve testing Continuity Theory (AV) for those conditions not examined in Shipley & Kellman (1992) (i.e. when linear extensions meet at an angle $< 90°$) and in Ciocca and Bregman (1987) (i.e. when linear extensions meet at an angle $> 90°$).

References

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