

Auditory Precedence Effect



Barbara Shinn-Cunningham*

Center for Computational Neuroscience and Neural Technology, Boston University, Boston, MA, USA

Synonyms

[Law of the first wavefront](#)

Definition

The precedence effect is a well-studied phenomenon in spatial hearing that is related to how we localize sounds accurately in everyday settings. Specifically, when two sound sources reach a listener close together in time, listeners often hear a single “fused” image whose perceived direction is near the location of the first-arriving sound.

Detailed Description

The Effects of Room Acoustics on Auditory Spatial Cues

The signals reaching the listener’s ears directly from a sound source convey information about the source’s location (Blauert 1997; Schnupp et al. 2010). However, in ordinary settings, soon after the direct sound reaches the listener, reflected sound arrives from random directions, coming off of walls, floors, and other reflective surfaces. This reflected sound energy adds acoustically to the direct sound before entering each ear, changing the total signal reaching the ear (e.g., see Allen and Berkley 1979). The content of this reflected sound energy depends on the geometry of the listening space, the positions of objects in the space, and the location and orientation of the listener. Moreover, the reflected sound energy differs at the left and right ears. As a result, this late-arriving sound distorts the spatial information conveyed by the direct sound, degrading the spatial cues in the total signal. As a result, the acoustic location information in the signals a listener hears in everyday settings is less reliable after an initial “clean glimpse” of the direct sound that happens at sound onset, before the reflected energy arrives.

The Precedence Effect

Perceptually, judgments of the direction of a sound source depend strongly on spatial information in the onset of sound and relatively weakly on spatial information in later-arriving portions of sound (e.g., see Brown and Stecker 2010). This phenomenon is known as the precedence effect (Wallach et al. 1949; Zurek 1987; Litovsky et al. 1999). Given that in ordinary listening spaces the onset of the sound has the most reliable information about source direction, the precedence effect is

*Email: shinn@cns.bu.edu

thought to be one of the reasons why listeners are relatively good at judging source location even when listening in rooms.

The precedence effect has been studied extensively with pairs of clicks (one leading and one lagging); for such brief stimuli, the precedence effect is strongest when the leading click precedes the lagging click by 1–5 ms and then rapidly becomes weaker (so that listeners start to hear the second click as a separate event and then begin to localize it with increasing accuracy; see Blauert 1997). For more “natural” sounds, like speech or music, the precedence effect persists for tens of ms. Many researchers argue that the precedence effect has a longer time course for ongoing signals because they can be thought of as containing multiple “onsets” due to local energy fluctuations, each of which can add to the precedence effect (e.g., see Zurek 1980).

Mechanisms of the Precedence Effect

Although the precedence effect is often discussed as a single psychophysical phenomenon, many different mechanisms likely contribute to the dominance of early spatial information on later-arriving information. For instance, the most peripheral portion of the auditory system, the auditory nerve, responds more vigorously at the onset of a sound than to later-arriving portions of a sound. This peripheral adaptation helps explain why a lagging sound that arrives within a few milliseconds of a leading sound does not convey strong spatial cues (Hartung and Trahiotis 2001). However, there are numerous studies that show that the perceptual dominance of the leading sound extends beyond very brief lead-lag delays that can be fully explained by peripheral adaptation. It is likely that microcircuitry in the brainstem contributes to the precedence effect at longer lead-lag delays through some type of inhibition triggered by the leading sound (Xia and Shinn-Cunningham 2011).

Cross-References

- ▶ [Sound Localization and Experience-Dependent Learning](#)
- ▶ [Sound Localization in Mammals, Models](#)

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