Measuring the auditory dynamics of selective attention

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Call it the cocktail party effect: how an individual can participate in a one-on-one conversation within a cluster of people, switch to another, pick up important comments while tuning out others, change topics and return to the first conversation.

This selective switching of attention which relies on disengaging and re-engaging attention to different voices on a time scale of a tenth of a second, can pose challenges for anyone with normal hearing.

However, the same crowded scene presents far more problems for the hearing impaired who have trouble listening to one sound and ignoring others in everyday settings like a restaurant or in a business meeting. They struggle to listen -- even with a hearing aid -- and are often exhausted and frustrated by their efforts, unable keep pace with other people who can tune out voices and more precisely pick out and stay with one conversation.

A first step toward helping hearing impaired listeners requires a better understanding of how people with normal hearing perceive and process a mix of sounds over time. This auditory ability to switch attention and, in the next instant, reset focus on whatever the new speaker says is something about which little is known. The dynamics of this process-- the time it takes to more precisely hear what is being said in environments with competing sounds – has received little study in the field of neuroscience. It is also the subject of a recently completed research study entitled "Object continuity enhances selective auditory

attention," published online in the *Proceedings of the National Academy of Sciences* (PNAS) on August 21, 2008.

The authors are Barbara Shinn-Cunningham, a Boston University professor and Director of Graduate Studies in the Department of Cognitive and Neural Systems, and graduate students Virginia Best, Erol J. Ozmeral and Norbert Kopco.

The research team measured this complex acoustic scene by studying how switching attention spatially influenced a listener's ability to recall a sequence of spoken digits. Five loudspeakers were distributed horizontally in front of the listener. The listener identified sequences of four digits presented either from the same loudspeaker or from different ones chosen randomly on each digit. Visual cues – lights – indicated the target loudspeaker at each temporal position in the sequence. The remaining four loudspeaker presented simultaneous distractor digits, the study noted.

The study also examined normal listeners' reactions when the target voice changed from digit to digit as well as conditions in which the target voice was the same.

The results showed that the recall of the spoken digits was best when they all came from the same loudspeaker compared to hearing each number from different speakers. Recall of the sequence degraded when listeners had to instantaneously switch attention to a new location for each digit. Thus a listener got better at filtering out sounds from others when they focused attention to a voice at a fixed location.

Sustaining attention to one continuous auditory stream led to refinements in selective attention over time. This improvement over time depended on the perceived continuity of the stream of target digits—the improvement was greatest when the digits sounded like they came from

one person talking from a fixed location. The progress was reduced when different voices spoke each target digit and when delays between the digits were abnormally long (so that each digit was perceived as an isolated number). Researchers also measured how fast a listener would switch or redirect their hearing the stream of digits – the finite time required to disengage and then re-engage attention.

"These findings shed light on why, in listening environments such as noisy parties or restaurants, it is more difficult to follow a conversation involving many people (where the relevant talker often and unexpectedly changes locations) than to focus on one talker (at one location) exclusively," the study concludes. "In addition, these results may have implications for visual attention in tasks where object formation and target segmentation is challenging, or where the identity of a visual object depends upon continuity of visual features over time."

Prof. Shinn-Cunningham will be continuing studies of how the brain controls auditory attention in complex settings through a National Security Science and Engineering Fellowship. The prestigious fellowship, recently awarded to six individuals from an initial pool of over 500 applicants, will enable Shinn-Cunningham to undertake a five-year program that uses both behavioral experiments and direct, non-invasive measures of electrical brain activity to extend her studies of how attention enables us to communicate in settings with multiple, competing sounds.

Source: Boston University