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Study finds hearing 'meaningful' sounds decreases performance on cognitive tasks

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Open office plans are becoming increasingly common in the workplace—offering a way to optimize available space and encourage dialogue, interaction and collaboration among employees. However, a new study suggests that productive work-related conversations might actually decrease the performance of other employees within earshot—more so than other random, meaningless noises.

The results of the study, led by Takahiro Tamesue, an associate professor at Yamaguchi University in Japan, will be described during the 172nd Meeting of the Acoustical Society of America and the 5th Joint Meeting with Acoustical Society of Japan, being held Nov. 28-Dec. 2, 2016 in Honolulu, Hawaii.

In their work, the researchers investigated the impact of meaningless and meaningful noises on selective attention and cognitive performance in volunteers, as well as the degree of subjective "annoyingness" of those noises.

The experiments were based on the so-called "odd-ball" paradigm—a test used to examine selective attention and information processing ability.

"In the odd-ball paradigm, subjects detect and count rare target events embedded in a series of repetitive events. To complete the odd-ball task it is necessary to regulate attention to a stimulus," Tamesue explained. Tamesue's laboratory focuses on improving auditory environments by

analyzing the physiological and psychological effects of noise.

In one trial, a visual odd-ball paradigm, subjects observed pictures flashing on a PC monitor as meaningless (for example, a pseudo voice-noise consisting of a pink noise with a spectrum closely resembling that of speech) and meaningful sounds (male and female speech) were played to both ears through headphones. The most frequent image—appearing 20 percent of the time—was 10 x 10 centimeter-square green image; the most infrequent was a red square. The subjects had to count the number of times the red image flashed on the screen over a 10-minute period. In a second trial, an auditory odd-ball paradigm, the subjects had to detect and count an infrequently played noise—a 2,000-Hertz tone—amid a series of 1,000-Hz tones. At the end of the trial, the subjects also rated their level of annoyance at each sound, on a seven-point scale.

During this and other experiments, the subjects' brain waves were measured through electrodes placed on their scalp. In particular, the researchers looked at two parts of the electroencephalograph (EEG) waveforms generated during the trials. The first, the so-called N100 component of event-related potentials (ERPs, brain responses caused by particular sensations, thoughts or motions), peaks about 100 milliseconds after a stimulus is presented. The second, the P300 component of ERPs, peaks around 300 milliseconds after the presentation of a stimulus.

"The N100 is thought to represent the activation of neural assemblies involved in the analysis of incoming sensory information," Tamesue said. "The P300 is thought to reflect the resolution of uncertainty or the perceptual decision that an expected signal has occurred. The peak amplitude and latency of this component is related to selective attention and working memory."

The study revealed that more meaningful noises, such as music and conversation, had a stronger effect on levels of subjective annoyance

than meaningless noises—and led to a greater decline in performance on cognitive tasks involving memory or arithmetic tests. In addition, when meaningful noise such as speech was presented to the subjects, their EEG measurements showed large reductions in the P100 and P300 components, indicating that selective attention to cognitive tasks was influenced by the degree of meaningfulness of the noise. The effect was most pronounced during the auditory odd-ball paradigm test.

The experiments suggest that when designing sound environments in spaces used for cognitive tasks—such as the workplace or schools—it is appropriate to consider not only the sound level, but also meaningfulness of the noise that is likely to be present, Tamesue said. "Surrounding conversations often disturb the business operations conducted in such open offices. Because it is difficult to soundproof an open office, a way to mask meaningful speech with some other sound would be of great benefit for achieving a comfortable sound environment," he said.

More information: Poster 4aPPa24, "Effects of meaningful or meaningless noise on psychological impression for annoyance and selective attention to stimuli during intellectual task," by Takahiro Tamesue is at 8:00 a.m.-12:00 p.m. HAST, Dec. 1, 2016 in Room Coral 3.

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