Effect of workplace sound level on physiological well-being revealed in new study

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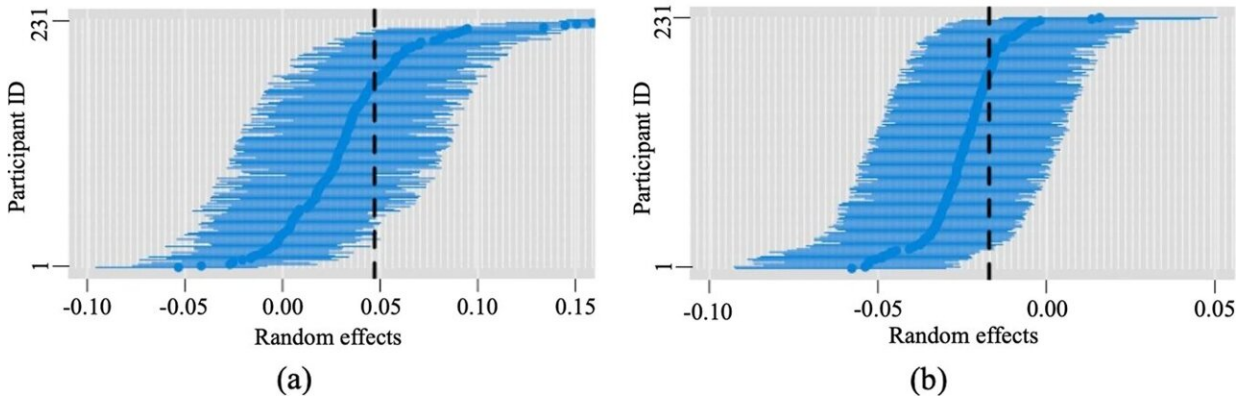

Caterpillar plots of posterior estimates of varying coefficients of sound level and their 60% credible interval in the empirical Bayes model. The vertical dashed line is the fixed effect coefficient while the horizontal blue lines indicate the random effects of sound level on physiological well-being across participants. a Caterpillar plot for sound level =50 dBA. Credit: *npj Digital Medicine* (2023). DOI: 10.1038/s41746-022-00727-1

The sound made by a refrigerator is just 50 A-weighted decibels. A ringing telephone generates 70 dBA, a leaf blower 110 dBA and a jet engine 150 dBA.

But how do these noises affect employees who are exposed to them

every day at their workplace?

"It's a really complex relationship when you think about how sound affects people," said Karthik Srinivasan, assistant professor of business analytics at the University of Kansas. "Some of us like quiet environments; some of us like noisy environments. We have a fair understanding from a psychological perspective, but much needs to be understood in terms of physiological effects of prolonged sound level exposure."

That was the impetus for his new study titled "Discovery of associative patterns between workplace sound level and physiological well-being using wearable devices and empirical Bayes modeling," published in *npj Digital Medicine*. The study recruited 231 federal office workers who wore multiple devices (around the neck or strapped on the chest) that assessed how sounds experienced in an indoor setting affects individual well-being.

It reveals that physiological well-being is optimal when sound level in the workplace is around 50 dBA. At lower (50dBA) amplitude ranges, a 10 dBA increase in sound level is related to a 5.4% increase and 1.9% decrease in physiological well-being, respectively. Age, body-mass-index, high blood pressure, anxiety and computer-intensive work are factors that contribute to specific variations in the results.

He said, "We looked at how we can capture the effect of sound on two different representations of physiological stress. One is primarily related to parasympathetic stress response; the other is a combination of parasympathetic and sympathetic stress response. So, in laymen terms, it means that when you are stressed, the parasympathetic and sympathetic responses are related to your body's fight-or-flight and rest-and-digest functions respectively, to cope with stress."

Srinivasan was lead author on the paper, which was part of the Wellbuilt for Well-being project led by the University of Arizona. It involved a large team of collaborators that included principal investigator Esther Sternberg, Faiz Currim, Matthias Mehl and Sudha Ram, all with the University of Arizona; Casey Lindberg, with the University of Arizona and HKS Architects; Javad Razjouyan and Bijan Najafi, both with Baylor College of Medicine; Brian Gilligan, Judith Heerwagen and Kevin Kampschroer, all with the U.S. General Services Administration; Hyoki Lee with University of Arizona and Best Buy; Kelli Canada, Logistics Management Institute; and Nicole Goebel and Melissa Lunden, both with Aclima.

The team was assembled to conduct this study for the U.S. General Services Administration (GSA), an agency with more than 10,000 employees that manages all the federal buildings in the nation. Research teams were composed of four groups: environmental, physiological, psychological and analytical. The study took place between 2015-2016 and focused on office workers in Texas and Washington, D.C.

"Ultimately, the GSA was very interested in understanding how we can make better workplaces," Srinivasan said.

He said that one of the key lessons of the paper is that while sound level does affect individuals inside the office workplace, its effect is not linear as might be expected.

"Higher sound levels are not good, but so are very low sound levels," he said, noting the optimal level resides around 50 decibels ampere.

"The second lesson we learned was this sound level association with physiological well-being is different for different people. We looked at various job roles and demographics, and we learned if participants who fell under the category of computer-intensive work or had high blood

pressure, their physiological response to sound was different from the other participants."

For example, the high blood pressure group proved more susceptible to sound, whereas the computer-intensive group was less affected when compared to the average participant.

Srinivasan began working on this project while a doctoral student at the University of Arizona. He's now in his fourth year at KU, where his expertise is in machine learning interpretability.

"When we think about well-being, typically we think about emotional or mental well-being," he said. "We hardly ever consider the physiological well-being or the actual 'what's happening in our body,' which is also important to understand when we're continuously exposed to environmental factors such as sound."

More information: Karthik Srinivasan et al, Discovery of associative patterns between workplace sound level and physiological wellbeing using wearable devices and empirical Bayes modeling, *npj Digital Medicine* (2023). DOI: 10.1038/s41746-022-00727-1

Provided by University of Kansas