Negative effects of background sounds on our memory

In contrast to your eyes, which you can close or cover to block out the visual world, your ears have no mechanical way to eliminate unexpected or unwanted sounds. You simply cannot avoid the auditory world. There are definite advantages to this: you catch all relevant sounds, even if their sources are out of sight such as a car coming up behind you or a fire alarm. A downside, however, is that it can be detrimental any focal task.

For instance, the effects of background noise can reduce work efficiency in open-plan offices, shared working environments and hospitals. Young children may have trouble reading or doing arithmetic in noisy classrooms. And if a surgeon or air traffic controller can’t focus, the consequences could be terrible – although any relevant alarms should be able to cut through their focus.

In my thesis, I investigated and improved a psychoacoustic metric – a measure for how sound influences your brain – which attempts to predict how bad the effect of a specific type of background sound is. This metric is called the frequency domain correlation coefficient (FDCC). It was recently proposed in the literature and is the only metric so far that is solely designed to predict how much of an effect different types of background noise will have.

I first studied the influence of background sounds on a single focal task, the serial-recall task. In a serial-recall task, participants are asked to recall seven to nine verbal items (e.g. letters or single-digit numbers) in the order they were presented on a screen one at time. This procedure was either accompanied by various irrelevant background sounds (I tested dozens of different sounds, varying from noise to altered speech sounds, and created several of them myself) or by silence, the control condition. I then calculated the short-term memory disruption, known as the ‘‘irrelevant sound (or speech) effect’’ (ISE), by comparing the scores between different acoustic conditions (e.g., speech and silence).

It is thought that an ISE only occurs if the background sound can be separated into “tokens” – pieces of sound – that are different in frequency or spectral content. This is known as the changing state hypothesis. Other hypotheses ascribe a special role to the speech stimulus. I analyzed the background sounds I used based on the FDCC metric, to see if the observed decreased memory performance was worse for those sounds that the FDCC predicts to have strong effects.

The results of the series of studies I did, show that the FDCC indeed appears to be a valid predictor of the ISE, especially predicting the high disruption of speech and masked-speech sounds: the spectral variation in background noise plays an important role in its capacity to distract people. This knowledge may be useful when designing rooms where people need to do tasks that depend on memory, since different designs and acoustic elements can change background noise into something less distracting. However, the studies also reveal limitations of the metric, indicating that the FDCC is not the final answer to fully understand and predict the ISE.

Title of PhD-thesis: An evaluation of a psychoacoustic model of the changing-state hypothesis.
Supervisors: Armin Kohlrausch, TU/e, Sam Jelfs, Royal Philips.