

All eyes and ears – literally!



Dr Francesca Yoshie Russo, ENT surgeon and Assistant Professor at Sapienza University of Rome, Italy

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New study on pupillometry and listening effort in people with cochlear implants

The expression ‘to be all eyes and ears’, meaning to be attentive, is taking on a whole new meaning with developments in pupillometry. Studies now show that the pupil dilation can reveal how much mental effort is being expended by people with cochlear implants during listening.

“Anyone with a long duration of hearing loss is familiar with the conventional audiometry tests used to evaluate hearing loss and quantify the benefits of a hearing treatment, such as cochlear implants,” says Dr Francesca Yoshie Russo, ENT surgeon and Assistant Professor at Sapienza University of Rome, Italy. “They know that the amount of effort they spend during these tests will impact their performance. This is an important parameter which current clinical tests do not capture.”

Listening effort is the deliberate allocation of mental resources to overcome obstacles when carrying out a listening task¹. According to the Framework for Understanding Effortful Listening (FUEL), how much listening effort a person spends depends on a person’s hearing difficulties, the task demands and the person’s motivation to expend mental effort in that specific situation.

Measuring listening effort

Dr. Russo and her colleagues conducted a pupillometry study to assess listening effort. Pupillary dilation can be used to measure cognitive processes as it occurs when the sympathetic nervous system triggers a fight-or-flight response.

The team presented short words in quiet and in noise to ten adult Oticon Medical cochlear implant patients. The patients had to repeat the words and their pupil dilation was studied using an eye tracker, which looks like a small computer screen, placed in front of the patients. All words were short and consisted of three phonemes, or speech sounds. “The task was not easy for the patients as the words were presented in isolation, without any context,” qualifies Dr. Russo.

The eyes show what the brain hears

On average, patients were able to repeat 60% of the words in quiet and 34% of the words in noise. Interestingly, when noise was introduced, pupil dilation increased. This shows that listening in noise is not only more difficult for people with cochlear implants, but it also requires more effort. Patients with larger pupil dilation also reported significantly more hearing difficulties on a questionnaire, the Speech, Spatial and Qualities of Hearing Scale (SSQ). In this way pupillometry reflects the difficulties many cochlear implant patients report in their daily lives.

Pupil dilation was classified in two ways. Firstly, it was noted how much pupils dilated when people were able to correctly repeat 0, 1, 2, or all 3 phonemes of a word and secondly pupil size was measured before, during and after the word was presented. Interestingly, directly after the word was presented but before patients repeated it, pupil dilation was different depending on the number of phonemes that were later correctly repeated. In other words, the patient's pupil size indicated whether the patient had heard the word and could repeat it.

Results with the potential to change listening tests

"It's an exciting finding, as it could pave the way to objective and non-invasive measures of speech perception in people with hearing loss," says Dr. Russo. "Imagine if we could tell whether cochlear implant patients are able to understand a word or not simply by recording their pupil size, without them having to repeat the word. This is also another step towards qualifying speech perception scores with a quantification of the effort the patient invested in the task."

Pupillometry is one of several promising tools to improve objective quantification of cochlear implant performance in clinical settings. Dr. Russo can also see the implications of pupillometry as part of listening tests for potential cochlear implant candidates. "The amount of effort expended by a patient in understanding speech is important knowledge. Effortful listening, as measured by pupillometry, could one day become one of the indications for cochlear implantation candidacy."

Dr. Russo carried out the study during her ENT fellowship at the Otology and Cochlear Implant Unit, Pitié-Salpêtrière Hospital in Paris, under the direction of Dr Isabelle Mosnier and Prof Olivier Sterkers. The full study was recently published in the peer-reviewed journal *Frontiers in Neuroscience*ⁱⁱ. [Read the article.](#)

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ⁱ [Pichora-Fuller et al, 2016](#)

ⁱⁱ [Russo et al, 2020](#)