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# Clinical results

Reducing listening effort with primax


Hearing Systems

SIEMENS

# Clinical Results: Reducing Listening Effort with primax

When we think of hearing aids that are optimal for a given patient, one of the first things that comes to mind is improved speech understanding, especially in background noise. One factor, however, which does not receive the attention that it should, is the amount of listening effort required by the patient to realize this optimal fitting in everyday use. That is, we have to "work harder" to hear what we want to hear. Often this involves situations with excessive background noise, but it also occurs for soft speech, poor cell phone connections, trying to understand a speaker with a pronounced foreign dialect, and many other difficult listening situations. When hearing loss is present, the listening situations that require more effort increase substantially. Research has shown that as expected, the use of hearing aids does reduce listening effort for the hearing impaired.

## Methods to Assess Listening Effort

Several approaches have been used in research to assess listening effort. These include physiologic measures (e.g. pupil dilation, heart rate, skin conductance, and salivary cortisol levels), recall and reaction time paradigms, and subjective assessment scales. In our current study, we used an innovative objective method for measuring listening effort based on the EEG recordings of trains of electrical events produced by the brain during a speech recognition task; the EEG sample is extracted to precisely coincide with the given task. For meaningful interpretation of the EEG activity, mathematical calculations of phase vector are conducted (the Rayleigh Test), which then results in scaled values from 0.0 (no effort) to 1.0 (extreme effort).

Using this objective method of listening effort, we examined the effectiveness of two new features of the Signia primax 7px hearing aids. We presented a group of hearing-impaired participants with difficult speech-in-noise listening tasks, and recorded the EEG activity when a given primax feature was "on" vs. "off." To establish the relationship between this objective measure and the participants' behavioral perceptions, we also had the listeners rate listening effort on a 13-point scale.

## Clinical Research Methods

The participants in this study were eleven adults with bilaterally symmetrical downward-sloping sensory/neural hearing losses. They were all experienced hearing aid users.

The two features of the new Signia primax that were studied were SpeechMaster and EchoShield. SpeechMaster is a comprehensive steering engine that orchestrates the different features and processes to minimize listening effort, regardless of the situation. It applies three principal strategies to improve the signal for the user: analyzing signal type, direction, and loudness. In this way, primax provides the first technology that isolates the target speaker from unwanted speech in all situations. For their evaluation, the OLSA (Oldenburg Sentence Test) sentences were used as the target speech material, with a background noise signal comprising of competing OLSA sentences. The target speech signal was from a 0 degree azimuth, and the competing speech was from seven loudspeakers surrounding the listener. Prior to assessing listening effort, the SNR of the OLSA was adjusted individually to a point where the listener could "just understand" the target speech with the algorithm "off". At this SNR, the sentences in background noise were presented with EEG activity collected in both conditions. At the conclusion of each test run, the participants also rated their subjective listening effort.

The EEG was recorded using a commercially available bio-signal amplifier; 8 active electrodes were placed according to the international 10-20 system. A trigger signal indicated the onset and offset of each target speech stimuli, and therefore, the EEG data could be analyzed precisely during the presentation of the target speech.

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## Results

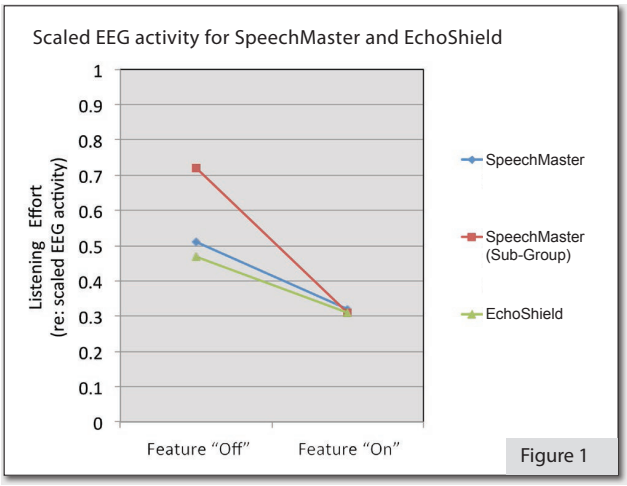

Figure 1

To examine the effectiveness of the new features of primax, the collected EEG findings were examined, comparing brain activity for the different conditions (e.g., uniformity when the feature was activated, to when it was not). For both SpeechMaster and EchoShield, the objective brain behavior measures revealed a significant reduction in listening effort when the feature was activated ($p<.05$).

The findings for the mathematically scaled uniformity for both features are shown in Figure 1, illustrating the reduced effort when both features were activated. For the SpeechMaster findings, a bimodal distribution for the omnidirectional (TruEar) condition was observed. That is, 45% of the participants had an effort of >0.6 for the omnidirectional condition, whereas the other 55% only had an effort of around 0.3 for this same condition. The subgroup shown in Figure 1 are those participants who had the greatest effort rating for the control condition—observe the increased benefit for these individuals.

As a cross-check to these objective findings, we reviewed the participants' behavioral ratings that were completed at the same time as the EEG recordings. These findings were in good agreement with the objective brain behavior data, and the mean findings are shown in Figure 2. The most notable findings were those for the listening task used for the SpeechMaster testing, where the participants were surrounded by competing speech signals. Note that for the omnidirectional (TruEar) setting, on average, the participants' rated the listening effort as "Considerable to Very Much Effort." However, with the SpeechMaster turned on, listening effort improved to an average rating of "Little Effort."

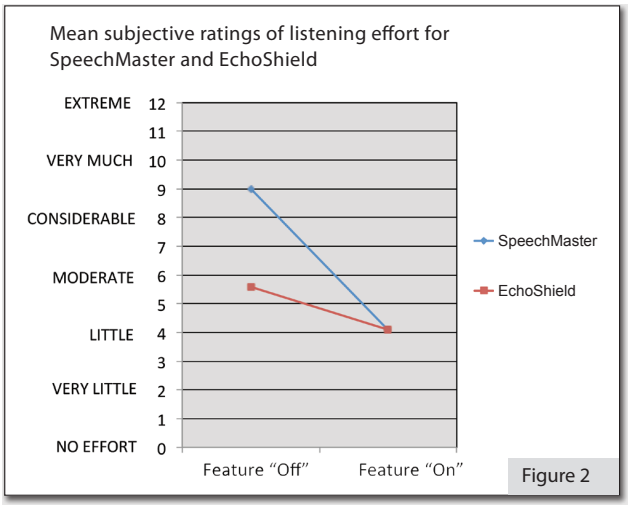

Figure 2

## Summary

For many hearing aid users, increased listening effort is present throughout the day, even when they are not aware. We know that effortful listening can increase the cognitive load, which will negatively impact simultaneous mental processes, such as multi-tasking. This in turn can lead to listening fatigue, associated with tiredness or a lack of energy, lack of concentration, and not having mental efficiency. Clearly, reducing listening effort is an important part of the overall hearing aid fitting process.

We have shown that the new features of the Signia primax instruments significantly reduce listening effort in different environments. Importantly, this was documented using an objective assessment of brain activity. As listening effort is reduced, our patients are better equipped to engage in other mental activities, including focusing on speech communication. The expected outcome is improved benefit and satisfaction with hearing aids.

Hearing Systems

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