

INTRODUCTION

Despite the remarkable prevalence of hearing loss in the United States, only 20-25% of these individuals utilize hearing aids. A myriad of factors associated with non-adoption of hearing aids have been acknowledged, including claims that they are “not worth the expense” and a financial burden, as well as the stigma associated with hearing aid use (Kochkin, 2007).

As an alternative to hearing aids, there are numerous hearing assistive technologies (HAT) or assistive listening devices (ALD) that currently exist to improve sound transmission to a listener by amplifying sounds and reducing the effects of distance from a speech source and background noise.

A more recent category of assistive technology that was introduced in 2008 is a personal sound amplification product, or PSAP. Personal sound amplification products (PSAPs) are discrete, wearable, and affordable electronic devices designed and marketed to be used by non-hearing impaired consumers to amplify sounds related to various recreational activities such as hunting, bird watching, “cleaning up” a conversation to be heard in a noisy room, etc. Food and Drug Administration guidelines clearly state that PSAPs are devices intended to amplify environmental sound for non-hearing impaired consumers, and that they are not intended to compensate for hearing impairment (Food and Drug Administration, 2013).

Etymotic Research Inc. manufactures a PSAP known as the “BEAN Quiet Sound Amplifier” that is sold on their website for \$375.00. The manufacturer claims that the BEAN boosts soft high-pitched sounds heard in speech, which helps provide clarity for conversations, particularly in less-than-ideal listening environments. Technical specifications for the BEAN include: 15-23 decibels of gain, analog signal processing, wide dynamic range adaptive compression, maximum output levels from 112.5 dB SPL to 114 dB SPL, 3% total harmonic distortion (THD), 10A zinc-air battery type, and two weeks of battery life (Etymotic Research Inc., 2014).

PSAPs could offer a gateway for consumers who may struggle with their hearing, but do not struggle enough to warrant spending large amounts of money on a pair of hearing aids at this time. If the claims made by PSAP manufacturers about their devices are supported, then perhaps audiologists will be more inclined to offer this cost-effective option to begin to enhance the listening abilities of a percentage of their patients with mild hearing loss who are not ready to adopt hearing aids. Positive experiences with PSAPs as starter devices may promote their use as a “stepping stone” towards individually programmable hearing aids.

OBJECTIVES & RESEARCH QUESTIONS

The purpose of this study is to investigate the future potential for personal sound amplification products (PSAPs) and to assess some of the claims made by the manufacturers, particularly for the Etymotic BEAN Quiet Sound Amplifier. Obtaining such information may allow the researchers to predict the acceptability and usefulness of personal sound amplification products for normal hearing and hearing impaired persons. The following research questions were addressed:

1. Is there a statistically significant qualitative improvement in speech recognition ability in the presence of background noise when wearing the BEAN as compared to the unamplified condition?
2. What are the attitudes toward Personal Sound Amplification Products (PSAP) such as the BEAN in regard to aesthetics, ease of use, comfort, perceived benefit, willingness to pay, etc.?

METHODS

Twenty fluent English speaking adults between the ages of 21 and 35 years with normal hearing sensitivity and normal middle ear function participated in this study. Two different personal sound amplification products (PSAP) were utilized for data collection: the Etymotic BEAN and the Sound World Solutions CS50. Recorded NU-6 word lists and Auditec multi-talker noise were utilized to determine speech recognition testing in the presence of competing background noise. Two versions of a questionnaire were developed.

Prior to the collection of data, participants were screened via pure-tone audiometry and tympanometry to ensure that they were not at risk for hearing loss or middle ear issues. Test stimuli were delivered through a single speaker, with participants seated at zero degree azimuth. Participants completed speech-in-noise testing in three different test conditions: unaided, aided using the Etymotic Bean PSAP, and aided using the Sound World Solutions CS50 PSAP. In each of the three conditions, a recorded NU-6 word list in addition to multi-talker noise were presented simultaneously at 50dBHL with a 0 dB signal-to-noise ratio (SNR). Participants were then asked to complete two brief regarding their attitudes towards each of the PSAP.

RESULTS & DISCUSSION

Statistical testing using a one-tailed paired t-test revealed no significant differences in speech recognition ability in noise while wearing The BEAN when compared the unamplified condition ($p=0.38745$)

Despite claims made on the Etymotic Research Inc. website (2014) that the BEAN is capable of adjusting to surrounding noise levels to provide clarity in less-than-ideal listening environments, the normal hearing participants in this study did not display any notable improvement in speech recognition in noisy environments.

Questionnaire results displayed primarily positive attitudes towards the BEAN. Interestingly, participants were more willing to pay for the BEAN than the CS50, despite no significant difference in benefit to speech understanding in noise.

The positive questionnaire outcomes obtained from this study in conjunction with earlier literature determining PSAP devices are functionally comparable to prescriptive hearing aids in many situations supports the likelihood of a potential increase in the market for PSAP devices in the near future of audiology. Findings suggest that perhaps audiologists could benefit from recommending PSAPs as a viable option for patients with lesser degrees of hearing loss who are not yet ready to adopt hearing aids.

FUTURE RESEARCH

Further research should aim to explore the benefit of PSAP devices to speech recognition ability in noise for listeners with slight to mild hearing loss, or for listeners who complain of self-perceived hearing difficulties despite having normal hearing.

It would also be advantageous to investigate the benefits of and attitudes towards PSAP devices in older adult populations, considering that adults with age-related hearing difficulties are likely to express interest in such a device

Given what is known in the literature about the benefits of binaural amplification with traditional hearing aids in background noise, future research should examine the benefits of using one PSAP versus binaural PSAP devices, particularly in the presence of noise.

Since hearing assistive technology often utilizes directional microphones to suppress background noise and enhance the speech signal, future should should aim to assess benefit of PSAPs to speech understanding in noise if the background noise was presented from behind the listener (180 degrees azimuth) or from the sides (90 or 270 degrees azimuth).

Table 1. Word recognition ability in background noise (% correct)

Condition	Mean (SD)	Median	Range
Unaided	48.4 (9.644)	48	34 - 76
BEAN	47.68* (9.178)	48	28 - 70
CS50	47.92* (9.857)	48	28 - 64

* $p \geq 0.05$, no statistically significant difference when compared to unaided score

Table 2. Descriptive statistics for attitudes towards the BEAN

Variable	Mean (SD)	Median	Mode	Range
Ease of inserting/removing device	4.32 (0.852)	5	5	2 - 5
Ease of changing battery	3.6 (1.000)	4	4	2 - 5
Ease of changing volume/program	3.8 (1.080)	4	5	2 - 5
Physical comfort	3.96 (0.841)	4	4	2 - 5
Appearance/aesthetics	3.88 (1.013)	4	4	2 - 5
Sound quality	3.56 (0.870)	4	4	1 - 5
Perceived benefit to speech understanding in noise	3.0 (1.01)	3	2	1 - 5

Note: 1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very Good

Table 3. Descriptive statistics for attitudes towards the CS50

Variable	Mean (SD)	Median	Mode	Range
Ease of inserting/removing device	3.6 (0.707)	4	4	2 - 5
Ease of changing battery	4.76 (0.436)	5	5	4 - 5
Ease of changing volume/program	3.84 (1.106)	4	5	1 - 5
Physical comfort	3.4 (1.041)	3	3	1 - 5
Appearance/aesthetics	2.84 (0.934)	3	3	1 - 4
Sound quality	3.12 (0.726)	3	3	2 - 5
Perceived benefit to speech understanding in noise	2.76 (0.879)	3	3	1 - 4

Note: 1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very Good

Table 4. Descriptive statistics for willingness to pay for the BEAN & CS50

PSAP	Mean (SD)	Median	Mode	Range
BEAN	3 (1.225)	3	4	1 - 5
CS50	2.64 (1.150)	2	2	1 - 5

Note: 1 = Very Unwilling, 2 = Somewhat Unwilling, 3 = Neither Willing Nor Unwilling, 4 = Somewhat Willing, 5 = Very Willing

REFERENCES

- Etymotic Research Inc. (2014). Bean: Quiet sound amplifier. Retrieved January 1, 2015, from <http://www.etymotic.com/consumer/personal-sound-amplifiers/bean- qsa.html>
- Food and Drug Administration (2013). Guidance for industry and FDA staff: regulatory requirements for hearing aid devices and personal sound amplification products. Retrieved January 1, 2015, from <http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments>
- Kochkin, S. (2007). MarkeTrak VII: Obstacles to adults non-user adoption of hearing aids. *The Hearing Journal*, 60(4), 24-50.