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Attitudes of Normal Hearing Listeners Towards Personal Sound Amplification Products: Sound World Solutions CS50

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ATTITUDES OF NORMAL HEARING LISTENERS TOWARDS PERSONAL SOUND AMPLIFICATION PRODUCTS: SOUND WORLD SOLUTIONS CS50

by

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Abstract

ATTITUDES OF NORMAL HEARING LISTENERS TOWARDS PERSONAL SOUND AMPLIFICATION PRODUCTS: SOUND WORLD SOLUTIONS CS50

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Over 23 million individuals in the United States have some degree of hearing loss but do not own hearing aids. Individuals may choose not to adopt hearing aid technology for an assortment of reasons, including the stigma associated with hearing aids, cost of the devices, or denying the effects of hearing loss. Prevalence of hearing aid usage remains low despite research indicating that untreated hearing loss is correlated with decreased quality of life and accelerated cognitive decline. In recent years, personal sound amplification products (PSAPs) have entered the market as simple, low cost, discreet devices in attempt to reach non-users of amplification.

The purpose of this study was to determine if the Sound World Solutions CS50 PSAP affects speech understanding in noise in normal hearing adult listeners. Listening to speech in noise is difficult for a majority of those with hearing loss and an important situation the CS50 is marketed to help improve. Such claims, however, have not been substantiated. This study also examined the experience of these individuals with the CS50, including their attitudes on ease of use, comfort, and willingness to pay, via a brief questionnaire.

Results of this study indicated that there is no significant difference in the speech recognition in noise scores of normal hearing listeners when they are unaided and when they are aided monaurally with the CS50 device. Overall, individuals judged the ease of

inserting/removing the device, changing the battery, and changing the program and volume to be good to very good. Physical comfort, appearance of the device, sound quality, and benefit to speech understanding in noise were judged to be fair. A majority of individuals were somewhat unwilling to spend $200-$300 on this device should they require amplification.

Lack of significance among speech in noise scores and fair judgments of many factors regarding the Sound World Solutions CS50 PSAP may have resulted from not truly assessing the device's directional microphone and testing only normal hearing listeners who do not have as much need for an amplification device as an individual with hearing loss. Further testing on individuals with hearing loss may help determine of this device would benefit such a population.

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Introduction

Approximately 30.0 million Americans, or 12.7% of the United States' population, have a bilateral hearing loss and 48.1 million Americans, or 20.3% of the population, have a bilateral or unilateral hearing loss (Lin, Niparko, & Ferrucci, 2011). As the population ages, the prevalence of hearing loss will continue to rise as the percentage of individuals with hearing loss steadily increases with each decade of life (Lin et al., 2011). Despite the 26.2 million people over the age of 50 that have an audiometric hearing loss, or that have an average hearing threshold at 500, 1000, 2000, and 4000Hz of ≥26dBHL, only 3.8 million Americans, or 14.2%, wear hearing aids (Chien & Lin, 2012). Prevalence of hearing aid usage is lowest in younger individuals and those with milder hearing loss and increases both with age and with hearing loss severity (Chien & Lin, 2012). Hence, almost 23 million individuals in the United States have a hearing loss and go without the assistance of amplification (Chien & Lin, 2012).

While satisfaction with hearing aids has increased with advances in technology, the number of individuals who have adopted hearing aids has not (Cox, Alexander, & Gray, 2005). Much research exists as to why the acceptance rate of hearing aids is so low when compared to the number of individuals who have a measurable hearing loss. One of the main reasons individuals decide not to pursue amplification is due to the stigma associated with hearing loss (Preminger, 2007; Wallhagen, 2010). In fact, 48% of those who do not utilize amplification cite stigma as their reason for non-adoption (Kochkin, 2007). Many individuals feel that hearing loss is socially unacceptable and do not want to be associated with the shame, disgrace, or embarrassment that is connected to the impairment (Preminger, 2007). The invisible disability of hearing loss becomes visible when wearing a device in one or both ears. By wearing a hearing aid, individuals feel as though they are admitting to themselves and to the outside world that they are aging and deteriorating. They do not want family members, friends, or even outsiders to treat them differently (Kochkin, 2007). These feelings are not unwarranted, as family members and communication partners have been known to be less supportive of their partner pursuing hearing aids for fear that they will be stigmatized by association when communicating with a person with visible hearing loss (Wallhagen, 2010). It does not come as a surprise that even when hearing aids are purchased, perceived stigma affects the particular hearing aid selected, as well as when and where the aids are worn. Most individuals with hearing loss find it important to hide the hearing aid as much as possible and to avoid drawing attention to their ears. Even advertisements marketing hearing aids to the public reinforce the stigma associated with hearing loss by emphasizing smaller, less visible hearing aids, rather than advertising the value of communication or showing younger people with hearing loss to combat the belief that hearing aids are only for the elderly (Wallhagen, 2010).

Another major factor influencing non-adoption of amplification is cost of the device itself (Gopinath et al., 2011; Chia et al., 2007; Kochkin, 2007). With cost of hearing aids ranging from approximately $1000-$3000 for one device, and double for someone with bilateral hearing loss, many find that they cannot afford to invest in a device that will improve their hearing and communication abilities (Gopinath et al., 2011). Analysis of a comprehensive survey of adults with hearing loss that do not wear hearing aids showed that 76% of adults with the greatest amount of loss name finances as a major reason for non-adoption of hearing aids (Kochkin, 2007). Approximately 64% of adults claim they cannot afford amplification in general, while 52% and 45% state hearing aids are too expensive to maintain, such as by consistently purchasing batteries, and not worth the expense, respectively (Kochkin, 2007). At this point, individuals must begin to consider if the advantages of amplification outweigh the cost of the devices. An individual's willingness to pay for one or two hearing aids can be predicted by how he or she rates the benefit the device provides, while taking into account his or her income; those who found greater benefit from the devices in categories such as easing communication and understanding in background noise, were willing to pay more for the device (Chisolm & Abrams, 2001). The average amount a person is willing to pay for such a device is $981.71, with this price increasing by $22.06 for each additional increment the individual feels the aid improves on their global hearing and communication (Chisolm & Abrams, 2001).

Denying that one has a hearing loss is another reason individuals may refuse to wear hearing aids. Two-thirds of individuals will not perceive a hearing handicap until five years after a hearing loss is audiologically diagnosed (Gopinath, et al., 2012). While this may be due to societal stigma or self-pride, there are many adverse effects to leaving hearing loss untreated. Individuals who ignore the effects of their hearing loss are known to have a decreased quality of life, negative well-being, depressive symptoms, and increased risk of mortality (Gopinath et al., 2011). These individuals may choose to isolate themselves, avoid social interactions, and fake their way through communication misunderstandings (Preminger, 2007). Hearing loss is also associated with accelerated cognitive decline and incident cognitive impairment in older adults (Lin et al., 2013). These adverse effects occur even in those individuals with mild hearing loss (Chia et al., 2007). Interventions that target self-perceived hearing handicap can also help to prevent the mental decline and preserve the physical well-being of those with hearing loss (Gopinath et al., 2012). It is important for individuals to acknowledge their hearing difficulties, as those who are more likely to self-report disabling effects of their hearing loss are also more likely to adopt hearing aids and thus begin to overcome the negative effects of such impairment (Cox, Alexander, & Gray, 2005; Gopinath et al., 2011). Wearing hearing aids improves quality of life scores, encouraging even those with mild hearing losses to consider audiologic intervention (Chia et al., 2007).

Additionally, adoption rates for hearing aids are lower in those patients whose audiologists do not take a patient-centered approach to hearing heath care and do not address the psychosocial concerns of their patients (Grenness, Hickson, Laplante-Lévesque, Meyer, & Davidson, 2015). By lacking patient engagement in the treatment process and shared decision-making, the individual is less likely to adopt hearing aids or adhere to wearing the selected hearing aids (Grenness et al., 2015). Realistic expectations of individuals are also important in determining hearing aid uptake and satisfaction. If the hearing aid performs better than expected and they experience fewer problems than anticipated, they will be more satisfied with amplification and more likely to continue wearing the aids (Meyer, Hickson, Khan, & Walker, 2014).

A myriad of assistive hearing technologies exist for those individuals who recognize that they have a hearing loss and are willing to take the steps to improve their communication. Assistive technology is defined by Cowan and Turner-Smith (1999) as “any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increases the ease and safety with which the task can be performed.” Assistive technology options that facilitate the ease with which people communicate exist along a hearing healthcare continuum ranging from technologically advanced hearing aids down to simple amplifiers.

Modern, digital hearing aids are available for individuals that have a diagnosed hearing loss, self-perceived activity limitations and participation restrictions, and are deemed hearing aid candidates. A hearing aid is intended to compensate for impaired hearing and is thus deemed a medical device by the U.S. Food and Drug Administration (FDA), which is defined as an instrument or apparatus intended to cure or treat a disease or affect a function of the body without chemical action within the body (U.S. Food and Drug Administration, 2014). All hearing aids must comply with regulations the FDA has set forth, such as the content of the hearing aid user manual and correct labeling of the device with the model, serial number, and date of manufacture (U.S. Food and Drug Administration, 2013). The FDA also regulates the sale of hearing aids in that an audiologist or hearing aid dispenser cannot dispense a hearing aid to an individual unless he or she provides medical clearance. A licensed physician must medically clear an individual within six months of receiving hearing aids by stating that his hearing loss has been medically evaluated and that he is a hearing aid candidate. A waiver of medical clearance is possible if the individual is over 18 years old, as long there is full disclosure by the audiologist or dispenser. Additionally, the dispenser must retain statements of medical evaluations and waivers for three years after the date of dispense (U.S. Food and Drug Administration, 2013).

Hearing aids are highly customizable for each individual person. The individual along with the audiologist or dispenser agree on the appropriate style and specific features within the aid that will best meet the needs of the patient. As hearing aids are customizable to an individual's particular hearing loss configuration, they are able to benefit individuals in many ways, including enhancing soft speech, easing communication in noisy and reverberant environments, and enabling the perception of high frequency sounds (Dillon, 2012). Despite evidence highlighting the benefit of hearing aids, many people with hearing loss remain skeptical about purchasing such devices.

On the other end of the spectrum, assistive listening devices exist in a variety of forms with different capabilities to meet a listener's needs. They are less costly, posing less of a financial burden, and are a good starting point for targeting a listener's specific needs. All of these devices intend to help a listener perceive speech and non-speech sounds in a way that reduces the activity limitations and participation restrictions associated with hearing loss. For example, they help overcome the distance between the speaker and listener, improve signal-to-noise ratio, and promote an optimal environment for communication (Weinstein, 2012). Audiologists do not traditionally dispense these devices, as the financial return is not substantial; for these reasons, only 2% of hearing aid dispensers' gross revenue comes from the sale of assistive listening devices (Ross, 2004). This number underestimates the value these devices can provide to individuals, especially those not ready or unwilling to purchase a more technologically advanced, and expensive, hearing aid.

Assistive listening devices fit into four major categories: personal listening systems, media devices, telecommunication devices, and alerting systems. The aim of personal listening systems is to facilitate and optimize face-to-face communication. One such system is the Williams Sound pocket talker. A pocket talker is a portable, single unit amplifier containing a microphone to pick up a speech signal, an amplifier to amplify that speech signal, and headphones for the listener to receive the amplified signal (Williams Sound, LLC, 2014). It can be hard wired or wireless and can work with or without a hearing aid. This device works well for individuals that do not use hearing aids but can benefit from amplification in difficult listening situations (Dillon, 2012). Frequency-Modulated (FM) system also works as a personal listening system. With this device, a sound signal is picked up from a microphone worn by the speaker and transmitted wirelessly via FM radio waves to the receiver headphones worn by the listener. The speech signal is amplified and sent directly to the listener's ears, bypassing the negative effects of distance, reverberation, and background noise. This device helps individuals with all levels of hearing impairment and provides a direct and consistent signal to the listener (Schafer

& Wolfe, 2010). Only 3.1% of elderly individuals with hearing impairments utilize personal amplifiers such as these, though many more would benefit (Hartley, Rochtchina, Newall, Golding, & Mitchell, 2010). In fact, one study found that while speech perception was greater when using an assistive listening device alone or in addition to a traditional hearing aid and while individuals anecdotally preferred the sound quality of the assistive listening device, only 2.7% of older adults chose to purchase and utilize such a device over a hearing aid for everyday use (Jerger, Chmiel, Florin, Pirozzoio, & Wilson, 1996).

Media devices fall within a category of assistive listening devices that help with broadcast and electronic media. Hearing loop systems can be found in large group areas, such as conference rooms or places of worship. A copper wire is placed around the room, creating an electromagnetic field. The acoustic signal of the speaker is picked up by a microphone and converted into an electromagnetic signal. This signal bypasses all background noise and reverberation and is picked up by the receiver headphones, creating a personal loudspeaker. Anyone within the room wearing induction loop receiver headphones, or using the telecoil feature of their hearing aids, will be able to benefit from the hearing loop (Dillon, 2012). Infrared (IR) devices are also utilized in large group settings, such as theaters. Sound is sent from the speaker to the receiver worn by the listener via infrared light waves. Infrared devices also facilitate home television listening. A transmitter is connected to the television or cable box and the signal is transmitted to a headset worn by the listener. Volume on the headset can be adjusted to a desirable level, while others watching television can keep the volume at a comfortable level. In both cases, these devices give the listener a clear and consistent signal directly to the ears ("Infrared Systems," 2015). Bluetooth technology is also used to connect wirelessly to electronic media. By wearing a headset or streamer with Bluetooth capabilities, an individual can connect to his cell phone, television, computer, MP3 player, car navigation system, or any other Bluetooth capable device and have the sound stream directly to his ears at an amplified level through a short-range, personal network.

Telecommunication devices enable communication via telephones for those with hearing impairments. Amplified telephones increase the incoming sound signal by 20-50 dB, depending on the severity of the listener's hearing loss. Strap-on amplifiers can also be used on any telephone, amplifying the caller's voice 18-40 dB. Some telephones even contain digital signal processing technology to make the softer sounds of human speech audible while keeping loud or unwanted sounds of background noise or echoes at a comfortable level. This enables even those without hearing aids to communicate more efficiently on the telephone ("The Digital Clarity Power Difference," 2015). Telecommunication relay service enabled telephones are another device that makes it easier for those with a hearing impairment to speak on the phone. These devices allow those with a hearing impairment to contact others with a standard telephone. A communication assistant uses voice recognition technology to provide essentially real-time captions for the hearing impaired individual on a large screen. All that is required for this service to function is a landline telephone and Internet access ("CaptionCall," 2014). Manufacturers of these telephones, such as CaptionCall and CapTel, are able to provide this product to those with documented hearing loss at low to no cost as mandated by Title IV of the American with Disabilities Act (Endres, 2009).

Finally, alerting systems are assistive listening devices that make environmental sounds more audible to those hard of hearing, thereby improving safety. Telephone and doorbell signalers will flash a connected lamp on and off when they ring. Warning devices, such as smoke detectors and baby monitors, use high-intensity sirens or flashing lights to signal when there is an emergency. To wake up to an alarm clock, the buzzer can sound up to 113 dB or a connected bed vibrator, placed between the mattress and box spring, will shake the bed at the preselected time. An individual also has the option of wearing personal signaler, which will vibrate when any activity occurs, such as the telephone and doorbell ringing or smoke alarm sounding (Smith, 2015).

Considered to be a form of disruptive innovation, a new hearing healthcare device has entered the market—the personal sound amplification device (PSAP). These devices are not classified as traditional hearing aids and are more akin to assistive listening devices on the hearing healthcare continuum. They are a simpler and less expensive alternative to hearing aids, though more technologically advanced than straightforward assistive devices such as the pocket talker. PSAPs were introduced in 2008 and can be purchased over the Internet, through the mail, or in electronics stores (Kochkin, 2010). While some PSAPs look similar to hearing aids, others resemble Bluetooth devices or ear buds and are paired to the ear with disposable ear tips. Prices of these devices range from as little as $10-$100 for low-range PSAPs to up to $500 for midrange PSAPs (Callaway & Punch, 2008). Quality of PSAPs also differs greatly. Callaway and Punch (2008) found that low-range analog devices, while less expensive, provide too much gain in frequencies below 1000 Hz and too little gain in frequencies above 1000-2000 Hz, causing speech to remain difficult to understand. They also have higher than acceptable equivalent input noise values and high isolated peaks in higher frequencies, increasing the likelihood of feedback. Such a device would only be appropriate for the rare audiometric configuration of a reverse sloping hearing loss. Mid-range digital devices, on the other hand, utilize automatic gain control output processing and are more electroacoustically similar to traditional hearing aids. They have been found to have a frequency response through 6000 Hz and meet equivalent input noise standards and NAL-R targets. These devices could potentially benefit consumers with sloping hearing loss (Callaway & Punch, 2008). Moving forward, only mid-range PSAP devices will be discussed. While these products resemble hearing aids and provide gain across a range of frequencies, they are not fit prescriptively based on audiometric hearing loss results and are advertised predominantly for use during recreational activities, such as hunting, listening to birds, or hearing whispered or distant speech, creating confusion for potential consumers with hearing loss (Gaffney & Palmer, 2013).

To address this confusion, the FDA issued guidance on the regulatory requirements of PSAPs once they were introduced to the market. This guidance defines PSAPs as wearable electronic products that are not intended to compensate for impaired hearing. Instead, they are intended for individuals without hearing loss to amplify sounds in the environment or for recreational activities. Manufacturers are not required to register or list their PSAP products with the FDA as they are not medical devices and therefore subject to different regulations than hearing aids (Mann, 2009). Different hearing associations responded with comments and critiques of this guidance. The International Hearing Society and American Academy of Audiology feared the public would not be wholly aware of the appropriate use of hearing aids and personal sound amplifiers. They advised those who suspect a hearing loss to obtain an evaluation by an audiologist and emphasized the risk of using a PSAP when hearing loss exists (International Hearing Society, 2012; American Academy of Audiology, 2013). The Hearing Health Organizations, composed of the Academy of Doctors of Audiology, American Speech-Language-Hearing Association, and the International Hearing Society, asked that the FDA clarify and strengthen regulations over the many companies they found illegally marketing hearing aids under the term PSAP (American Speech-Language-Hearing Association, 2012). In

2013, the FDA responded by requiring the intended use of PSAPs be established for consumers by specific labeling of the device and promotional materials. They also stated that any product that claims to help an individual in listening situations typically difficult for those with hearing loss should not be considered a PSAP (U.S. Food and Drug Administration, 2013). This document, however, remains a recommendation of how to treat personal sound amplification devices—it is not legally binding or enforceable.

Despite the FDA guidance stating that personal sound amplification devices are not intended for individuals with hearing loss, many who could benefit from amplification do indeed purchase these devices as a substitute for traditional hearing aids. Over one-third of those with hearing loss are interested in a non-prescription PSAP to improve their hearing, and about 6% of hearing aid non-adopters with diagnosed hearing loss and 4% of individuals with self-reported hearing loss, equating to over 2 million individuals, have already purchased a personal sound amplification product (CEA Market Research Report, 2014). These people are more likely to be younger, less educated, and earn an average of $10,000 less per year than their counterparts who have decided to purchase traditional hearing aids. Audiologically, PSAP users are more likely to have unilateral hearing loss, mild hearing loss, and report less problems understanding speech in noise. They wear the device fewer hours each day and are less likely to purchase binaural devices (Kochkin, 2010; Gaffney & Palmer, 2013). A majority of current PSAP owners use their device to watch television, while only a quarter of PSAP owners use their device while talking on the telephone, performing leisure activities, and in large rooms and even less utilize the device in group conversations and noisy settings. Only 10% use them all day for every listening situation. Conversely, half of non-PSAP owners who are interested in purchasing a device believe they would receive the most benefit from the device in noisy situations, though only 17%

of individuals who do own a device use them in such situations, and slightly more than 40% of prospective buyers feel they would use the device every day in any situation (CEA Market Research Report, 2014). Interestingly, 82% of current PSAP consumers report satisfaction with their product compared to 64% of traditional amplification users (Gaffney & Palmer, 2013). This may be due, in part, to users' expectations of the device. If the user does not expect these less expensive, non-customizable devices to provide them much benefit, their satisfaction will increase if they perceive the device is helping them. On the other hand, individuals paying thousands of dollars for a traditional hearing aid may expect the device to greatly improve their hearing in all situations. If they do not perceive this to be true, their satisfaction with the device will decrease (Mormer, 2012).

These personal sound amplification devices were able to enter the hearing healthcare market due to the over 20 million Americans who have hearing loss but do not own a hearing aid. PSAP manufacturers seized the opportunity of marketing their devices to the large number of potential consumers with some difficulties hearing, but not enough to convince them to invest thousands of dollars on technologically advanced hearing aids. This is a prime example of a disruptive innovation in the field of audiology. A disruptive innovation is a simpler product that takes root at the bottom of a market and moves upward, potentially displacing existing traditional products (Fabry, 2015). Businesses start out small and low-margin and different attributes of the product are emphasized. This new way of competing within an existing business enables the product to eventually capture a share of the traditional market. In fact, over two-thirds of industries have adopted some form of a disruptive innovation (Charitou & Markides, 2003). In competitive markets, manufacturers fight for market share by constantly improving and advancing their products, or creating sustaining innovations, and charging high prices to their most demanding and sophisticated customers to accrue the greatest possible profits. Over 60% of traditional hearing aid sales are from existing high-demand users upgrading their devices and expecting the most advanced product. This enables disruptive innovations to succeed among low-demand users; the product is competing against non-consumption rather than other competitors or manufacturers. In the case of PSAPs, existing hearing aid users have no need or interest in the product, so it is being marketed to the millions of non-adopters of hearing aids at an affordable price (Fabry, 2015). There is something inherently different between the needs of current customers and non-consumers, in this case individuals who would purchase a hearing aid and one who would purchase a PSAP (Schmidt & Druehl, 2008) The PSAP market is capitalizing on these differences. Though approximately 79% of PSAP purchasers have hearing loss configurations similar to those individuals who wear custom hearing aids, and are themselves candidates for custom hearing aids, only 17.8% of them would have purchased hearing aids had PSAPs not been available (Kochkin, 2010). This indicates that the over 80% of PSAP users who would not have considered purchasing more expensive hearing devices are benefiting from amplification in situations where they would likely normally have difficulty hearing. Now, a new population at the bottom of the market has access to a hearing healthcare device, when traditionally only those with more disposable income could afford such aid (Fabry, 2015).

The hearing healthcare environment has changed with the advent of PSAPs and many audiologists have mixed opinions on what this will mean both for patients and for the profession itself. Many argue against utilizing PSAPs to aid impaired hearing. These audiologists strictly abide by the FDA guidance that PSAPs are not intended to compensate for hearing loss. If the devices are sold in stores or online, which is where 73% and 48% of potential consumers would prefer to purchase PSAPs, respectively, then the audiologist is being bypassed which is a threat to the profession (CEA Market Research Report, 2014; Callaway & Punch, 2008). No one would be monitoring the fitting of PSAPs to ensure that they will not damage a consumer's residual hearing any further (Callaway & Punch, 2008). Additionally, purchasing a PSAP in a drug store or on the Internet does not require an audiometric evaluation. This can cause a delay in the diagnosis of treatable hearing loss, which can lead to further complications down the line (Kochkin, 2010). Finally, these newer, less expensive products threaten the more profitable sales of traditional hearing aids. Even if private practice audiologists are not inherently opposed to dispensing PSAPs, it will be difficult for them to garner the same amount of profit they are making in the same amount of time when dispensing traditional amplification (Jameson, 2014).

Other audiologists feel as though PSAPs are an important innovation and can prove to be beneficial for their patients. Approximately one-third of individuals diagnosed with hearing loss would be willing to purchase a PSAP from an audiologist or a hearing aid dispenser (CEA Market Research Report, 2014). By dispensing PSAPs, the audiologist will be able to attract new customers as well as monitor patients' hearing and any changes that may occur over time. The audiologist would be able to ensure that the PSAP is fit correctly and show them how to insert it so that it fits correctly. They would also have the opportunity to counsel the patient on the limitations of the device, as well as instruct them on how to safely use the PSAP by not turning the volume up too loud. These audiologists also see the benefit that could be provided to the individual who only has a minimal loss, has a low perceived hearing handicap, and only wants to wear the PSAP in a few specific situations (Shaw, 2014). Additionally, if a patient is undecided about whether or not to purchase a hearing aid, utilizing a PSAP may help them to decide. As the cost of a PSAP is more in line with what consumers are willing to pay to improve their hearing, they may be less hesitant to try the device (CEA Market Research Report, 2014). Similarly, a consumer purchasing a PSAP with the help of an audiologist or hearing aid dispenser could be a first step towards that consumer purchasing a hearing aid; the PSAP could be a stepping stone towards traditional amplification if they are not yet ready to make such a large purchase. After using a PSAP, the individual may notice that the device did not help them in the situations they wanted or that it helped them enough in these situations to make them realize that they need more help from a traditional hearing aid (Shaw, 2014). Regardless, audiologists should personalize their sessions to each individual client and utilize a best practice approach in order to sustain their role of hearing healthcare professional and make the experience of purchasing a PSAP from them more favorable than purchasing one in a drug store or over the Internet.

The Sound World Solutions CS50 is one of the higher end personal sound amplification devices that some audiologists may begin to embrace as a possible solution for their patients with hearing loss who are not yet ready to purchase expensive hearing aids. The CS50 looks like a Bluetooth headset, with a piece both in and behind the ear. The device retails for $299.00 for either the left or right ear. The CS50 contains 16 channels, has a frequency response range from 200-8000 Hz, and provides up to 25 dB SPL of gain. It contains omnidirectional and directional microphones, with a hypercardioid polar pattern. Volume ranges -12 dB SPL to +12 dB SPL away from baseline and maximum output is 112 dB SPL. Total harmonic distortion is less than or equal to 1% and equivalent input noise is 26 dB SPL. The CS50 processes the incoming signal utilizing proprietary algorithms for dynamic compression, noise reduction, output compression, and feedback and echo cancellation. The device is powered by a rechargeable lithium ion battery that lasts up to 18 hours; each device is packaged with two batteries. Sound World Solutions also created a free Customizer application for iPhone and Android cell phones through which an individual can personalize and control the settings of the PSAP, including adjusting the settings of treble, mid, and bass frequencies. The CS50 is preset with three different environmental program settings. The first setting is the Baseline Setting for everyday, relatively quiet situations. The second program is the Restaurant Setting. This program utilizes a directional microphone to focus on sounds directly in front of the wearer and reject unwanted noise from the signal. The third program is the Entertainment Setting, which provides increased low frequency response in order for the signal to sound more natural at musical or theater events. Additionally, the CS50 is Bluetooth compatible with any Bluetooth enabled device up to 30 feet away, allowing users to stream phone calls, music, and other media through the device. Once audio begins streaming, the device will turn into audio mode. It will return back to amplification mode once the streaming ceases (Sound World Solutions, 2015).

Sound World Solutions' mission is "helping people get back in the conversation wherever they are and whatever their budget" (Sound World Solutions, 2015). The Sound World Solutions CS50 is advertised to help the consumer hear sounds around them with increased volume, sound quality, and clarity. It claims the device is helpful at home when listening to the television and at dinner parties by filtering out ambient noise. It also claims to minimize background noise through the use of the directional microphone, enabling easier listening in public spaces, airports, sporting events, boardrooms, restaurants, and at the movies. The Bluetooth capability is also advertised as making phone conversations much easier to conduct with increased clarity. The product's website does note that the CS50 is not a hearing aid and is meant to be used occasionally by individuals in situations that are inherently difficult to hear. Consumers who believe they have a hearing loss, or who feel they need to wear the device all day long, are encouraged to visit a professional (Sound World Solutions, 2015).

It is the objective of this study to determine the benefit of and attitudes towards the Sound World Solutions CS50 PSAP in the normal hearing listeners for whom it is FDA approved. It is our goal to determine if the Sound World Solutions CS50 PSAP provides benefit when listening to speech in noise and thus if wearing the device would be advantageous for potential consumers in such a situation. Additionally, we wish to determine if the device itself is acceptable to users in terms of aesthetics, ease of use, and comfort, and their willingness to pay for a device with these aspects.

Methods

Participants

English-speaking adults with normal hearing were recruited to participate in this study. To verify normal hearing, each individual's air conduction hearing was screened using insert earphones at 20 dB HL at octave intervals between 250 Hz and 8000 Hz. Tympanometry using a 226 Hz probe tone was performed on all individuals to confirm the absence of middle ear pathology. Each participant had an ear canal volume of less than or equal to 2.5 cm^3, tympanic peak pressure greater than or equal to -50 daPa, and static admittance between 0.3 and 1.8 mmhos. Individuals with current hearing loss at any of the screened frequencies or with present middle ear pathology were excluded from participating in this study. Qualified individuals signed an informed consent form and received $10 upon completion of testing, as a result of funding provided by a grant from the CUNY Graduate Center.

Instrumentation

All testing was performed in a double-walled sound booth meeting American National Standards Institute (ANSI) standards. A Grason Stadler GSI 61 two-channel clinical audiometer, calibrated to the ANSI S3.6-2010 specifications, was used to present recorded speech and noise material to participants.

Participants wore two different personal sound amplification products (PSAPs) separately during testing, the Sound World Solutions CS50 and the Etymotic Bean, and I report on outcomes when using the CS50. The CS50 PSAP is a behind-the-ear device that couples to the ear via a disposable ear tip. It is powered by a rechargeable lithium ion battery. The 16-channel device has a frequency response range of 200-8000 Hz, provides up to 25 dB SPL of gain, and utilizes digital signal processing and dynamic compression (Sound World Solutions, 2015). The CS50 was left at factory settings and the restaurant program was used for testing. This program utilizes a directional microphone to emphasize sounds coming from in front of the participant and reject unwanted sounds (Sound World Solutions, 2015). Volume was held constant throughout testing.

The Etymotic Bean PSAP sits in the concha of the ear by means of a disposable ear tip. It is powered by one disposable size 10 zinc-air battery. The Bean provides up to 15 dB of gain with a maximum output of 112.5 dB SPL in the normal setting and up to 23 dB of gain with a maximum output of 114 dB SPL in the high setting. The device was set to the normal position for testing. The Bean utilizes analog signal processing and wide dynamic range adaptive compression (Etymotic Research, Inc., 2014).

Speech in noise testing was performed using recorded Northwestern University Auditory Test Number 6 (NU-6) word lists. This material contains four lists of 50 monosyllabic, consonant-vowel nucleus-consonant (CNC) words presented in an open-set format. Each list is equivalent in difficulty. Words are preceded by the carrier phrase "say the word…" on recorded material. Within each list, phonemic balance exists in that the frequency of phonemes found in the target words is similar to the distribution of phonemes commonly heard in the English language (Tillman & Carhart, 1966). In order to increase reliability and validity of testing and lessen variability of test scores, 50-word lists were utilized. Recorded word lists were presented to each participant in order to retain consistency among test materials.

An 8-item questionnaire was given to participants to answer regarding their experience and attitudes towards the aesthetics, comfort, and ease of use of the PSAPs (shown in Appendix A). All items have 5 fixed choice responses on the Likert scale. Scores were rated on a 5-point scale, with 1 being very poor and 5 being very good. A final question regarding the participant's willingness to pay for the particular PSAP devices, should they feel they need sounds and speech be amplified, was also asked. Scores were rated on a 5-point scale, with 1 being very unwilling and 5 being very willing. Two versions of the questionnaire were created, each specifying the particular PSAP being studied.

Procedure

Speech in noise testing was performed in sound field in three separate conditions: unaided, aided monaurally with the Etymotic Bean PSAP, and aided monaurally with the Sound World Solutions CS50 PSAP. The order in which each participant completed the three conditions was randomized, as was the specific ear in which the participant wore the amplification device. Ear tip size and material for both PSAPs was selected by each participant to ensure their maximum comfort prior to testing the aided conditions. Proper placement and fit of each PSAP was verified by the principal investigators prior to testing.

Speech in noise testing was performed with the participant positioned 3 feet from the speaker at a 0° azimuth in a sound treated test booth. Both the NU-6 word-list recording and recorded multi-talker babble were calibrated on the audiometer's VU meter via a recorded calibration tone prior to presenting the material to participants. Word list tested under each condition was randomized for each participant. The word list and multi-talker babble were presented simultaneously through the speaker, each at 50 dB HL resulting in a 0 dB signal-to-noise ratio (SNR). Participants were instructed to ignore the noise they heard and to repeat each test word to the best of their ability, taking a guess if they were unsure. Each correctly repeated word was worth 2%, yielding a total possible score of 100%.

Immediately following speech in noise testing with each individual PSAP, an 8-item questionnaire was provided to the participant. The participant was given sufficient time to handle the device and utilize its features, such as turning the device on and off, changing the batteries, and switching programs, before answering the questionnaire. Participants were also asked to respond to the questionnaire keeping in mind their experience with the PSAP used during speech in noise testing. Responses to these questionnaires were then studied in order to discover trends in the attitudes of the participants to these particular devices.

Results

Twenty-five English-speaking adults, 16 females and 9 males, participated in this study. Ages ranged from 21 to 35, with a mean age of 25.3 years. All participants had normal hearing with no middle ear pathology based on a hearing screening and tympanometry.

Speech in Noise Testing

The results of speech in noise testing are shown in Table 1. Distributions of scores are shown in Figure 1 and Figure 2. An average sound field speech in noise word recognition score of 48.4% was obtained in the unaided condition. An average score of 47.92% was obtained when participants were monaurally aided with the Sound World Solutions CS50 PSAP. Statistical testing using a two-tailed *t*-Test for Paired Samples revealed no significant difference between the word recognition scores in the presence of background noise of participants in the unaided condition and in the monaurally aided with the CS50 condition.

Table 1: Speech in Noise Scores (% correct)

Condition	**Mean***	**Median**	**SD**	**Range**
Unaided	48.4	48	9.644	34 – 76
CS50	47.92	48	9.857	28 – 64

*$p \geq 0.05$ ($p = 0.805$; differences not significant)

Figure 1: Distribution of Speech Recognition Scores – Unaided

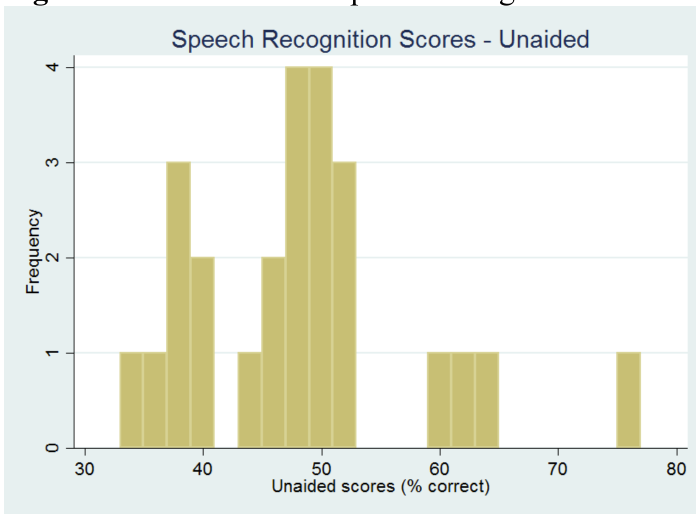
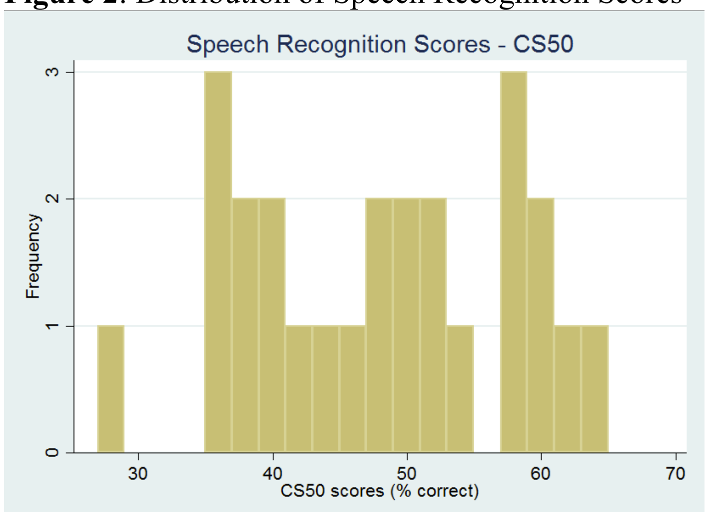


Figure 2: Distribution of Speech Recognition Scores – CS50



Questionnaire: Experience and Attitudes Towards the Sound World Solutions CS50 PSAP

The descriptive statistics regarding participants' experiences and attitudes towards the CS50 PSAP are shown in Table 2. The median and mode for all qualities asked about ranged from 3 to 5. Notably, the median and mode for ease of changing the CS50's battery was 5, or "very good." The median for ease of inserting/removing the device from their ear and ease of changing the volume and program was 4, or "good." All other categories, physical comfort, appearance/aesthetics, sound quality, and benefit to understanding speech in noise, have a median and mode of 3, or "fair." The lowest averages belong to the questions concerning participants' attitudes on the appearance/aesthetics of the device and the device's benefit to understanding speech in noise.

Table 2: Descriptive Statistics Regarding Experience and Attitude Toward CS50

Variable	**Mean**	**Median**	**Mode**	**SD**	**Range**
Ease of inserting/removing device from ear	3.6	4	4	0.707	2 – 5
Ease of changing the battery	4.76	5	5	0.436	4 – 5
Ease of changing the volume and program	3.84	4	5	1.106	1 – 5
Physical comfort	3.4	3	3	1.041	1 – 5
Appearance/aesthetics	2.84	3	3	0.943	1 – 4
Sound quality	3.12	3	3	0.726	2 – 5
Benefit to speech understanding in noise	2.76	3	3	0.879	1 – 4

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

Anecdotally, participants found the CS50 to be somewhat distracting when listening to speech in noise. Common complaints include the device was "too loud," "felt too big in the ear," "made sounds louder but not clearer," and "own voice sounded uncomfortable." Other participants, however, did notice a benefit of understanding in noise when wearing the CS50. One participant claimed that he realized the CS50 was helping him understand in noise once he compared listening to speech with the CS50 to when he was unaided. Another participant felt that "towards the end [of the word list] it seemed to help, possibly from adjusting" to wearing the device.

Questionnaire: Willingness to Pay

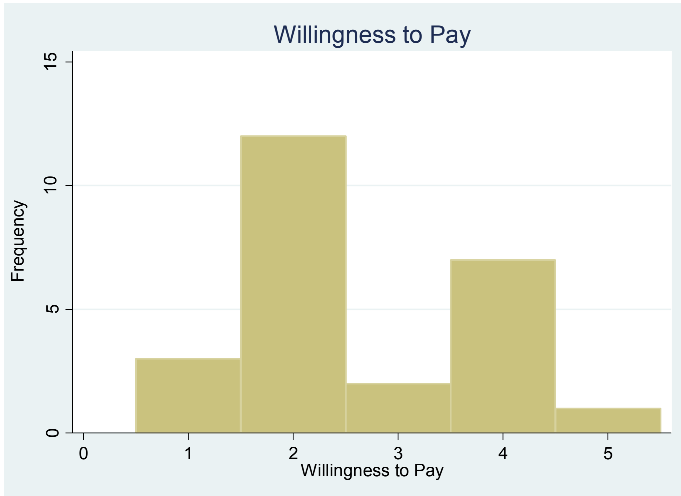
The descriptive statistics regarding participants' willingness to pay $200-$300 for the Sound World Solutions CS50 PSAP, should they need sounds to be amplified, are shown in Table 3. Fifteen participants were very unwilling or somewhat unwilling to pay this amount for the CS50, while only eight participants were somewhat willing or very willing to pay this amount. Distribution of participants' willingness to pay is displayed in Figure 3. Spearman's Rho Rank Correlation analysis performed with Bonferroni correction displayed significant positive correlations ($p \leq 0.05$) between willingness to pay and both ease of inserting/removing the device from the ear ($r = 0.6843$) and perceived sound quality of the device ($r = 0.6948$). In general, the easier participants found it was to insert and remove the CS50 from their ear, the more willing they would be to pay $200-$300 for the device. Similarly, individuals would be more willing to purchase this PSAP should they need sounds to be amplified if they perceived better sound quality of the device.

Table 3: Descriptive Statistics Regarding Willingness to Pay for CS50

	Mean	**Median**	**Mode**	**SD**	**Range**
Willingness to Pay	2.64	2	2	1.150	1 – 5

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

Figure 3: Distribution of Willingness to Pay Ratings



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

Discussion

The purpose of this study was to compare the speech in noise scores of normal hearing listeners when unaided and when aided monaurally with the Sound World Solutions CS50 personal sound amplification product. The goal was to verify the manufacturer's claims relative to speech understanding in noise. This study also examined these listeners' feelings and attitudes towards different aspects of the CS50 PSAP, including ease of use, appearance/aesthetics, and perceived benefit and sound quality. Listeners' willingness to pay for this device should they need sounds to be amplified was also determined.

Speech in Noise Testing

Many individuals with hearing loss report that they find it very difficult to understand speech in the presence of background noise. Modern digital hearing aids utilize directional microphones in noisy environments, which work to suppress noise coming from behind and the sides of an individual while preserving good sensitivity and amplification to the sounds and speech coming from straight ahead (Dillon, 2012). Similarly, Sound World Solutions advertises that the CS50 device contains a directional microphone that is active when set to the Restaurant Setting to filter out background noises, and claim that users will be able to understand conversations more clearly when in loud, crowded areas (Sound World Solutions, 2015). Results of this study indicate that there is no statistically significant difference between the speech in noise recognition scores of normal hearing listeners in the unaided and CS50 aided conditions when fit monaurally. Despite the Sound World Solutions' claim that listeners will be able to understand speech more clearly using their product, no benefit was found. These results are not surprising, as only 17% of current PSAP owners use their device in noisy situations (CEA Market Research Report, 2014), possibly due to a lack of perceived benefit.

Perhaps if participants were tested binaurally rather than monaurally, an improvement in speech understanding in noise would have been found. Disagreement occurs in previous research on whether amplifying one or both ears is more advantageous to understanding speech in noise. With speech and noise signals presented from the same speaker at a 0° azimuth, McArdle, Killion, Mennite, & Chisolm (2012) found that 80% of people perform better in noise when binaurally aided, Walden & Walden (2005) discovered that 82.1% of listeners understand more words in noise when monaurally aided, and Dirks & Wilson (1969) saw no significant difference in scores of monaurally and binaurally aided conditions. These studies did all note, however, that speech in noise scores are higher when the signal reaches both ears at a comfortable level, regardless of whether the individual is monaurally or binaurally aided (McArdle et al., 2012). Listening to speech in noise with both ears is advantageous, partially due to binaural redundancy, or the suppression of internal noise within each ear when both ears receive identical information. This can increase signal-to-noise ratio 1-2 dB and is true for those with normal hearing and those with hearing loss (Dillon, 2012). Since both ears of all tested participants hear symmetrically, amplifying the input of one ear causes the incoming signal to be higher in the aided ear, potentially negating the advantage of binaural redundancy. If both ears were wearing the CS50 PSAP, different speech in noise results may have been obtained.

Additionally, both the target word lists and the multi-talker babble were presented from the same speaker directly in front of the listener, likely affecting the speech in noise scores obtained. Both the speech and the noise were amplified, rather than just the speech itself, limiting the use of the device's directional microphone. This corroborates previous studies, which found that individuals made more errors while repeating speech in the presence of background noise when the competing speech was closer in location to the target words (Hawley, Litovsky, &

Colburn, 1999; Ozimek, Kociński, Kutzner, Sęk, & Wicher, 2013). Perhaps if the noise was presented from a different speaker at 90°, 180°, or 270° azimuth, scores would have increased in the aided condition.

As the FDA has only approved the CS50 and other PSAPs for normal hearing individuals, only those with normal hearing were tested. These are the individuals, however, that do not necessarily need amplification to understand speech, especially when amplifying competing noise makes differentiating the specific target words more difficult. The CS50 couples to the ear via an ear tip, acting as a plug in the individual's ear. While the plug itself simulates a hearing loss, it is overcome by the amplification they are receiving from the PSAP. It is possible that the effects of both the plug and simultaneous amplification cancel each other out, restoring the individuals hearing to baseline and creating no significant difference between aided and unaided speech in noise scores.

Questionnaire: Experience and Attitudes Towards the Sound World Solutions CS50 PSAP

Participants' ratings of the CS50 PSAP ranged widely across the provided scale for a majority of the features and questions asked regarding the device. While variations existed, physical comfort of the device was generally thought to be "fair" by participants, with some individuals noting that the device felt very big in the ear. Most participants rated the ease of inserting and removing the device from their ear as "fair" to "good," indicating they had only some or very little trouble properly placing the device in their ear or removing it after testing. One individual did note some trouble with insertion due to her small ear canals; while she "appreciated the small earbuds" included with the device, she still had a great deal of difficulty inserting the PSAP comfortably. Similar sentiments were found by Salonen et al. (2013), who discovered that 23% of elderly individuals who seldom or never wear their amplification devices refrain from doing so due to difficulty putting the aid in the ear. Therefore, the general simplicity of inserting the CS50, as found in this study, may be an important predictor for the potential use and adoption of the CS50 PSAP. Providing various styles of ear tips in addition to different size tips can also increase the comfort level and ease of insertion for those who are not happy with the fit of the three included ear tips.

Similarly, ease of changing the device's program and volume were rated quite high, with a median of "good" and most individuals selecting "very good." Though one participant found the volume button more difficult to handle, there were few complaints regarding this aspect of the device. Opinions on the ease of changing the CS50's rechargeable lithium ion battery were near unanimous, with all but six participants selecting that the ease of changing the battery was "very good." Not only are the batteries rechargeable, forgoing the high cost of consistently replacing disposable batteries that often deter those with hearing loss from purchasing amplification (Kochkin, 2007), but changing the battery is so simple it adds no additional burden to the user no matter his or her dexterity.

As previous research has noted, the appearance of a hearing aid or amplification device is very important for acceptability of the device due to perceived stigma associated with hearing loss (Kochkin, 2007; Preminger, 2007; Wallhagen, 2010). For this reason, the CS50 was designed specifically to look like a Bluetooth device, similar to one used by hands-free cellphone users, in order to appear unobtrusive and discreet (Sound World Solutions, 2015). When normal hearing adults were asked how they view the appearance/aesthetics of the CS50 PSAP, 36% felt the appearance was "fair," both "poor" and "good" were selected by 28% of respondents, and 8% believed the appearance was "very poor." No one believed the PSAP's appearance was "very good." This demonstrates that while some people do feel that the CS50 looks like a Bluetooth device and is a subtle way of aiding an ear that needs sounds to be amplified in certain situations, others still find the device to be too large and conspicuous for their tastes and preferences.

Both sound quality of the CS50 and perceived benefit of the device to understanding speech in noise were thought to be "fair" by large numbers of respondents (60% and 44%, respectively). Many participants complained that their own voice sounded uncomfortable when speaking while wearing the device. This is due to the occlusion effect, which occurs when the ear canal is occluded in an individual with good low frequency hearing thresholds, blocking bone conducted sound vibrations from leaving the ear canal (Dillon, 2012). Due to the inclusion criteria of normal hearing listeners in this study, along with the closed ear tips provided with the CS50, many participants were bound to notice an occlusion effect upon inserting the CS50. Unfortunately, open ear tips were not available to use with this device to determine if an open fit would decrease the negative comments regarding the CS50's sound quality. Others felt that hearing movements of their mouth and hearing their hair brushing against the microphone were bothersome, and some claimed incoming speech sounded "staticy." A surprisingly low number of people noticed a benefit from wearing the CS50 PSAP in noise; only 20% felt the device provided "good" benefit to understanding speech in noise, while the remaining 80% of participants believed the device provided them "very poor" to "fair" benefit when compared to their own unaided hearing. Many said that the target words and competing noise during testing were made louder, though words were not clearer and it was not affecting their ability to discriminate the words. As these listeners all had normal hearing, they had no previous experience with amplification with which to compare this device. Time during the session was provided for the participant to wear and practice using the CS50, though this was not enough time to truly acclimate to the sound of the device. It would be interesting to study how individuals with hearing loss who may have experience with a hearing aid or a personal sound amplification product would view the sound quality and benefit provided by the CS50 PSAP.

Questionnaire: Willingness to Pay

A majority of participants are “somewhat unwilling” to pay $200-$300 for the Sound World Solutions CS50 PSAP, should they need sounds to be made louder. 60% of participants are “very unwilling” or “somewhat unwilling” to pay this amount for the CS50, while nearly half the number, 32%, are “somewhat willing” or “very willing.” All participants had normal hearing in both ears and though they were instructed to imagine they did need sounds to be made louder before answering this particular question, it is very difficult to say they would purchase something, no matter the price, if they feel they do not need the services it provides. Additionally, most participants are attending graduate school or are young professionals. A value of $200-$300 for this PSAP may be different for these participants than it would for someone who is older or more established in their field. Someone who has more savings or feels that they actually do need the help of a personal sound amplification product may be more willing to pay this amount of money such a device. It would be difficult to generalize the willingness to pay of this study’s participants to those individuals that this disruptive innovation is marketed for.

It is interesting that participants’ willingness to pay $200-$300 for the CS50 PSAP is significantly positively correlated with the ease of inserting and removing the device from the ear and perceived sound quality of the device. As many people who do not wear their hearing aids on a daily basis find it difficult to insert the aid into the ear (Salonen et al, 2013), it follows that one would not want to purchase a device that they have a hard time placing in the ear. Additionally, if the sound quality was believed to be poor, individuals would be less willing to spend their money on such a device than if they felt the sound quality was natural and comfortable. This is not surprising, as Kochkin (2005) found that sound quality is very important to consumers when it comes to selecting and wearing a hearing instrument; clarity, richness, and naturalness of sound are highly correlated with customer satisfaction regarding their hearing devices. Of those unhappy with their hearing instruments, 88% wish for improvement in sound quality (Kochkin, 2002).

Surprisingly, no significant correlation between willingness to pay and appearance/aesthetics was found. Though many rated the appearance of the CS50 to be "poor," "fair," and "good," their views on the looks of the device did not influence whether or not they would be willing to purchase it. This shows that there is more that goes into the decision of whether or not to purchase an amplification device than just its aesthetics. There was also not a significant correlation between willingness to pay and perceived benefit in noise. This finding is contrary to those Chisolm and Abrams (2001) saw among their participants, who noticed that individuals were willing to pay more for amplification when they noticed a higher benefit to their global communication abilities. In the current case, participants used perceptions of the CS50's sound quality to gauge whether or not the it would be worth purchasing for $200-$300 rather than the perceived benefit the device provided them during the speech in noise listening task.

Limitations and Recommendations for Further Research

Counterbalancing the aided ear, test conditions, and NU-6 word lists presented eliminated the potential adverse effects of specific ear advantages, order effect, and fatigue on the results. Other limitations in the design of the study, however, may have influenced the results obtained. A major design flaw of this study was that the speech and noise were presented from the same speaker directly in front of the participant. To truly assess the directional capabilities of the CS50 microphone, the multi-talker babble should have come from behind the participant at a 180°

azimuth. This may have caused increased scores in the aided condition. Another limitation of this research was studying normal hearing listeners who do not need sounds to be made louder. It is possible that amplifying an ear that does not need amplification, as well as occluding the ear canal with the ear tip, may have affected the obtained results.

Further research that takes into account the limitations of this study should be performed to further investigate the benefits of the CS50 PSAP. It would be interesting to see if speech in noise scores improve when the CS50's directional microphone is fully taken advantage of by presenting multi-talker babble from an angle other than 0° and when the target words and background noise are presented at different signal-to-noise ratios. Furthermore, while the device is only FDA approved for normal hearing individuals, these are not the people that would likely purchase the device. Speech in noise testing should be performed on those with mild hearing losses, as those with this particular hearing loss configuration are more likely to forgo adopting a hearing aid and instead purchase a personal sound amplification device (Chien & Lin, 2012; Gaffney & Palmer, 2013). It would be interesting to see how those with hearing loss respond to the questionnaire and if their attitudes and opinions on the device differ from the normal hearing participants tested in this study.

Clinical and Theoretical Implications

While further research is necessary to determine if the Sound World Solutions CS50 benefits individuals with hearing loss, the CS50 has the potential to fill a previously untapped section of the hearing healthcare market. The CS50 is a device that addresses negative perceptions of hearing aids, such as high cost and associated stigma. It is a less expensive alternative to hearing aids and is aesthetically designed to resemble a Bluetooth device. Though the device should not be recommended to help normal hearing listeners understand speech in noise based on the results of this study, it does have the potential to help those individuals with hearing loss who do not wish to purchase a hearing aid or have trouble hearing in certain difficult listening situations. This study shows that some individuals are not opposed to using such a device and that it is simple enough to handle, leading to the inference that the device may be used as an acceptable stepping-stone for individuals not yet ready to purchase a traditional, more complicated hearing device. Should future research confirm advantages of this device, the number of individuals with hearing loss being served would increase, thereby improving the quality of life of those whose hearing loss would previously have been left untreated.

Conclusion

The results of this study indicated that the Sound World Solutions CS50 personal sound amplification product does not provide significant benefit to understanding speech in noise for normal hearing listeners when speech and noise come through the same speaker. While many listeners find the CS50 easy to handle and operate, most would be somewhat unwilling to purchase this device for personal use should they require amplification. Future research is necessary to determine the benefit of the CS50 on the comprehension of speech in noise in listeners with hearing loss and how these attitudes and opinions regarding the device would change if being judged by participants with diagnosed hearing loss. Further research is needed to determine if the CS50 PSAP is a viable alternative to traditional amplification in terms of cost and benefit to the user.

Appendix A: Questionnaire

Attitudes of Normal Hearing Listeners Towards Personal Sound Amplification Products:
SOUND WORLD SOLUTIONS CS50

1. How would you rate the ease of inserting and removing the CS50 from your ear?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

2. How would you rate the ease of changing the battery of the CS50?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

3. How would you rate the ease of changing the volume and/or programs of the CS50?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

4. How would you rate the physical comfort of the CS50 in your ear?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

5. How would you rate the appearance/aesthetics of the CS50?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

6. How would you rate the sound quality of the CS50?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

7. How would you rate the CS50's benefit to your speech understanding in noise, as compared to when you are not wearing any device?

Very Poor	Poor	Fair	Good	Very Good
1	2	3	4	5

8. If you needed sounds to be amplified/made louder, how willing would you be to pay $200-$300 for the CS50?

Very Unwilling	Somewhat Unwilling	Neither Willing nor Unwilling	Somewhat Willing	Very Willing
1	2	3	4	5

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