A Review of Home-Based Computerized Auditory Training Programs for Adult Cochlear Implant Recipients

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ABSTRACT

It has been documented that clinicians working in cochlear implant clinics that provide service to adult cochlear implant recipients feel they do not have sufficient expertise with auditory training protocols, don't have access to enough resources, and do not have enough manpower to offer auditory training to these individuals. Researchers and software creators have exhibited interest in home-based computerized auditory training that has resulted in more information with which the interested clinician and/or cochlear implant recipient must become familiar, in order to make educated decisions when recommending and/or purchasing software for home-use by an adult cochlear implant recipient. This paper provides a guide to busy clinicians, new clinicians, and cochlear implant recipients when considering computerized auditory training programs. Eight of the home-based computerized auditory training programs that are currently available were reviewed, exploring features such as cost, availability of trial versions, areas targeted for therapy, computer literacy and computer hardware required, possibility of use with mobile devices, as well as additional items.

INTRODUCTION

Every year from 2003 to 2007, an average of 296 deaf Canadian adults received cochlear implants (Fitzpatrick & Brewster, 2010). That represented significant growth, compared to 1998, when the average was 71 (Fitzpatrick & Brewster, 2010). There are a total of 12 adult cochlear implant service programs in Canada; Fitzpatrick and Brewster surveyed all of them in 2008. The programs reported various levels of rehabilitation for their adult cochlear implant recipients. None of the programs reported any provision of rehabilitation services from providers outside the program. Eight of the twelve programs offered in-house rehabilitation services; those eight reported that a range of 0-50% of their patients, depending on the site, accessed this component of service. Seven of the twelve sites reported that patients did not access rehabilitation services because they did not need these services post-implantation. Fitzpatrick and Brewster acknowledged that those reports came from the perspective of the clinicians who completed the survey. It would be valuable to compare this perspective with that of the adult cochlear implant users themselves. Would they agree that they do not require any rehabilitation? Might it be possible that benefits, that neither the clinician nor the client expected, could be achieved if some sort of rehabilitation protocol was initiated? Might an adult cochlear implant recipient exceed expectations? Might they become more comfortable using the device in a shorter period of time? Pallarito (2011) states that “fewer than ten percent of practicing audiologists offer comprehensive auditory training to their patients” (p.25). McCarthy and Schau (2008) outlined practical solutions that they felt might ease the challenges clinicians face when juggling the need for client-centred audiological rehabilitation and the lack of resources in which to provide a full range services. Statements such as those from Pallarito and

McCarthy and Schau, American professionals, suggest that the difficulties surrounding provision of aural rehabilitation are not limited to Canadian clinics.

Effective communication is more than just the physical ability to hear. It requires an individual to listen (hear with intention and attention), comprehend (understand the information heard), and finally communicate (a bidirectional exchange between communication partners) (Sweetow & Sabes, 2006). People who receive a cochlear implant may require assistance to learn how to use the signal the device provides. They may desire support when learning how to use this new signal to maximize hearing. Practice and improvement in any one of listening, comprehending, or communicating will serve to enhance abilities in the others (Sweetow & Sabes, 2006).

This support can be provided in the context of individual therapy, group therapy, and/or computer software programs designed to provide auditory training in the client's home. Individual therapy is costly and reimbursement is often not provided to the therapist (Fu & Galvin, 2007a; Pallarito, 2011). Individual therapy also requires appropriate clinical expertise and manpower, which Fitzpatrick and Brewster (2010) report was a major concern amongst Canadian cochlear implant service providers. This makes justification for providing individual direct therapy difficult for the therapist, and leaves the client to fund private service, if available, out of his own pocket. Individual therapy may well be assumed by clinicians to be the gold standard for rehabilitation therapy. For example, Ross (2005) describes his ideal rehabilitation program: "two full months of informational classes, speechreading and auditory training lessons, ongoing hearing aid selection procedures, and so on" (p. 30). In 2005, Sweetow and Palmer completed a systematic review of the literature exploring individual therapy for auditory rehabilitation. They found that there was little evidence, and none unanimous,

regarding its efficacy. They reported that there was positive support for therapy focused on active listening strategies and speech recognition in noise.

A second logical consideration is group therapy. It is a more cost-effective option, but does not always ensure that the individual needs of the client are met (Sweetow & Sabes, 2007a). Chisolm, Abrams, and McArdle (2004) completed a study that compared clients with hearing aids, but not provided follow-up auditory training, with clients who received hearing aids as well as auditory training. The training component was provided in a group setting. It was counseling-based, focused on teaching the client listening and communication strategies through conversation. Chisolm et al. reported greater short term benefits to the clients who received auditory training in a group setting when compared to clients who did not receive the training component. In most areas studied, the difference between groups disappeared after one year; the control group (i.e., hearing aid only) continued to improve resulting in both groups achieving equal scores after one year using the hearing aid. Abrams (2010) discusses the study above, in addition to a more recent one completed by Hickson, Worrall, and Scarinci (2007) who found that the clients who participated in an Active Communication Education group program showed significantly improved scores on a number of outcome measures, and that these benefits were maintained for at least six months.

A third format is computer software auditory training designed for home-use. Pallarito highlights software programs designed for auditory training as one possible option in the "comprehensive auditory training" protocol (p.25). Pallarito and others acknowledge that these programs have not been favoured as a rehabilitation option in the past (Pallarito, 2011; Ross, 2005; Sweetow & Sabes, 2006). As Ross and Pallarito each state, this is not a surprise given the lack of research supporting this approach to rehabilitation. Stacey et al. (2010) completed a

study with cochlear implant users using software-based auditory training. The majority of the clients, six out of eight, reported minimal to no perceived improvement in their psychological, social, and emotional well-being; two clients felt they experienced improvement in the areas of psychological, social and emotional well-being. The difference between individuals who experienced auditory training versus individuals who did not receive auditory training was only significant for consonant discrimination, not vowel discrimination or sentence tests. These results do not support the statistically significant results reported by Fu, Nogaki, and Galvin who completed a similar study in 2005. Fu et al. (2005) reported improvements in discrimination tasks focused on vowels as well as tasks focused on consonant discrimination. Stacey et al. acknowledged that differences in study design, time spent training, time since implantation, and effectiveness of software program used may have all played a role in the disparate results.

Throughout the exploration of the literature, as outlined in “Methods”, this author was not able to find research directly comparing the outcomes of any combination of individual vs. group vs. other formats (i.e., computer-based training). This author suspects that outcomes could vary greatly depending on a large number of factors (e.g., age, computer literacy, personality, personal support system, ease of attending site-based therapy, etc.) that may make one format preferable and, subsequently, more effective for any one individual adult cochlear implant user.

Stacey et al. (2010) speculated, as Chisolm et al. (2004) did, that implementing auditory training programming in any form may not actually provide significantly greater benefit than experience with a device, resulting in all users showing equal ability to use their devices effectively over time. However, Stacey et al. stated that the use of computerized auditory training may increase confidence and skill using the cochlear implant at a faster rate so that

similar results (as would be achieved with just experience) are achieved sooner. Abrams (2010) states that studies may also achieve better statistical results if the sample sizes were larger. Sweetow and Sabes (2007a) express that even small gains in communication competence may be very important to the function of an individual, and thus should not be discounted. Ultimately, Sweetow and Palmer (2005), Chisolm et al. , and Stacey et al. did not get overwhelming support for individual, group, or computerized auditory rehabilitation respectively; nevertheless, all authors acknowledge that results of including some component of auditory rehabilitation are not always statistically significant, but improvement in performance and individuals reporting feeling more confident using their device continues to offer promise for the use of auditory intervention. Miller, Watson, Kistler, Preminger, and Wark (2008) agree with the authors above, highlighting that evidence is growing for computer-based auditory training. Miller et al. (2008) feel that a new hearing device, in conjunction with effective training, will likely improve satisfaction, benefit from and use of a device. Perhaps users of devices should be consulted on an individual basis to determine if they would prefer to build their skill and confidence immediately with extra effort or if they are more interested in waiting for spontaneous improvements. Clinicians may also need to consider subsets of clients who will benefit from very focused training.

This brings the topic back full-circle to Fitzpatrick and Brewster (2010), who reported a lack of clinical expertise and manpower for the provision of aural rehabilitation. This is seconded by Pallarito (2011) who stated that professionals feel unprepared to provide training of this nature due to a lack of clinical guidelines. Considering all of these factors, why is the general trend for clinicians to not embrace software based auditory training programs (Ross, 2005; Sweetow & Sabes, 2006) that offer a prescribed approach?

Pallarito shares thoughts from Robert W. Sweetow, PhD, Professor of Otolaryngology at the University of California, San Francisco, who feels the lack of aural rehabilitation services stems from clinicians being focused on helping people to hear, not communicate. A lack of understanding, and need for ongoing research, may be another reason why clinicians often have not suggested such materials to clients in the past (Pallarito, 2011; Ross, 2005; Sweetow & Sabes, 2006). However, efforts are clearly being made by the creators of the software (i.e., Boothroyd, 2008; Fu et al.,2005, 2007; Miller et al., 2008; Sabes & Sweetow, 2007; Sweetow & Sabes, 2006, 2007a, 2007b) and other independent researchers (i.e., Martin, 2007; Stacey et al., 2010) to provide the research that might influence a resurgence in auditory training. Researchers, focused on auditory training programs designed for home-based use, express hope that these programs may combat challenges to implementing auditory training (i.e., lack of clinical guidelines, lack of funding, manpower limitations, literature to support use, etc.) (Bloom, 2004; Fitzpatrick & Brewster, 2010; Pallarito, 2011; Ross, 2005).

One could speculate about a variety of factors contributing to why minimal use of computerized auditory training programs persists despite researchers' high hopes for more widespread implementation. Clinicians might lack education regarding what is available to consumers. They may be too busy, and the highest priority may not be to shorten the time over which improvement is made when, as Chisolm et al. (2004) suggests, many of their clients will achieve a reasonable outcome spontaneously. Perhaps the cochlear implant users are not completely honest and direct about their successes and difficulties with the implant. Maybe the clients who really require the support and rehabilitation have long since given up the idea that cochlear implantation will work for them, abandoned use of their implants, or have completely

stopped attending the cochlear implant service appointments. Subsequently there may no longer be any dialogue between user and clinician (personal communication, D. Piplica, October 2009).

In order to encourage more widespread use of computer-based auditory training programs in adult rehabilitation, Sweetow and Sabes (2006) outlined criteria to be met by the program:

"...

- It must be cost effective.
- It must be practical and easily accessible; that is, it should be able to be implemented in the privacy and comfort of a patient's home.
- It must be interactive.
- It must be sufficiently difficult to maintain interest and attention while being sufficiently manageable to minimize fatigue.
- It must provide reinforcement to the patient.
- Training must take place near the individual's skill threshold.
- It must proceed at the patient's optimal pace.
- It must integrate listening training with repair strategies.
- It must provide the patient with feedback regarding progress or lack of progress.
- It must provide for measurement and feedback to the professional that is verifiable via remote access.
- It should make the patient assume some degree of responsibility for the ultimate outcome objective." (p.543)

In addition, researchers have found that any benefits of computer-based auditory training are dependent on patient motivation and commitment to practicing (Sabes & Sweetow, 2007; Sweetow & Sabes, 2010). Patient compliance in the area of therapeutic rehabilitation, while under the direct care of a health professional, was explored by Cameron (1996). She identified five major factors that can predict compliance: “knowledge and understanding”, “quality of interaction”, “social isolation and support”, “health benefits and attitudes”, “illness and treatment” (p.244-248). The author offers practical advice in these areas to increase patient compliance with therapeutic regimes. Clients need to understand their condition; therefore, health professionals need to share information in a simple, unambiguous manner. Satisfaction and likelihood of compliance are increased by the quality of relationship that the client has with his or her therapist. A friendly, rather than business-like manner, based on reciprocal information sharing, is preferred by clients generally. Individuals who have a personal support network with whom to share their goals and progress tend to have better compliance. Clients need to believe that the benefits of any program will outweigh the cost (costs may be defined as money, time, inconvenience, pain, etc.). A client who perceives to also have some internal locus of control over the program and/or his or her condition and is included in goal setting, may exhibit increased motivation to participate in a therapeutic regime. Sweetow and Sabes (2010) state that the same challenges that plague any health care or therapeutic regime carry over into software-based auditory training regimes; thus highlighting the benefits of Cameron’s (1996) suggestions to support consistent use of auditory training software programs.

Computer software programs focused on auditory training/developing listening and communication skills may be a more cost effective option for a motivated cochlear implant recipient (Fu & Galvin, 2007; Ross, 2005; Sweetow & Sabes, 2007b). There is no evidence to

suggest that any harm can be done from this approach to rehabilitation, short of wasted money if the client chooses not to engage in the program (Sweetow & Sabes, 2007a, 2007b). However, with FREE options available, it is quite possible for a cochlear implant user to explore his or her possible engagement with computer-based auditory training. Some individuals may even find that one of the free options sufficiently meets their needs to polish their listening skills and become fully functional communicators.

This paper was spawned when speech-language pathology student colleagues were wishing to complete auditory training with a bilateral cochlear implant recipient. The client had received his cochlear implants some time earlier and was not offered any follow-up rehabilitation. (This is not an unusual occurrence based on the information shared by clinicians with Fitzpatrick and Brewster (2010) in their survey of Canadian cochlear implant clinics.) The client purchased a software program that did not meet his needs and was not experiencing success in the area of auditory training and listening. The client came to the university seeking further assistance. The group of students assigned to this case found that the marketing summaries provided with the currently available software-based auditory training programs were not particularly helpful when attempting to choose the most appropriate program for their client (personal communication, M. Campbell, July 2011). This author wished to create a document that was user-friendly, relatively jargon free, comprehensive, and helpful to a clinician and/or device recipient with limited technical knowledge about auditory training, to choose the best software to meet his or her needs for a home program. The first step was reviewing the research surrounding computer-based auditory training for home use.

This author discovered three bodies of work that focused on comparison of computer-based auditory training programs (Olson and Canada, 2010; Ross, 2005; Sweetow and Sabes, 2007b).

Ross (2005) completed a clear, concise review of four programs:

- *Sound and Beyond* (Computer Aided Speech Training/CAST from TigerSpeech)
- *Seeing and Hearing Speech* (from Sensimetrics)
- *Listening and Communication Enhancement (LACE)* (from Neurotone Inc.)
- *Conversations Made Easy* (from Central Institute for the Deaf, St.Louis)

He addressed such topics as:

- creators/marketers
- cost
- targeted areas for improvement
- variety of tasks and levels within tasks
- feedback methods
- adaptation to client progress
- therapist involvement requirements
- recommended time commitment from client
- research studies completed, where applicable

Sweetow and Sabes (2007) completed a review of four programs:

- Computer-Aided Speech Training (CAST) which was, at the time, commercially marketed as *Sound and Beyond* from Cochlear Americas and *Hearing Your Life* from Advanced Bionics (no longer exists)
- Computer Assisted Tracking Simulation (CATS)
- *Computer Assisted Speech Perception Testing and Training at the Sentence Level* (*CasperSent*) created by Arthur Boothroyd
- *Listening and Communication Enhancement (LACE)* (from Neurotone Inc.)

They addressed such topics as:

- creators/marketers
- hardware/software requirements
- targeted areas for improvement
- analytic versus synthetic approach*
- variety of tasks and levels within tasks
- feedback methods
- adaptive to client progress
- therapist involvement requirements
- recommended time commitment from client
- research studies completed, where applicable

[*An analytic approach is focused on bottom-up processing, with drill-like activities using targeted stimuli (i.e., pure tones, nonsense syllables, words) (Olson & Canada, 2010; Sweetow & Sabes, 2007b). A synthetic approach is focused on top-down processing (i.e., sentence

completion and communication strategies, etc.) (Olson & Canada, 2010; Sweetow & Sabes, 2007b). Most programs offer the option to experience both types of listening activities; the degree of analytic versus synthetic activities depends on the creators' philosophy surrounding auditory training. Fu & Galvin (2007b) stated that hearing aid users may experience more benefit from a synthetic approach than cochlear implant recipients who may require more concentrated training in phoneme recognition using the cochlear implant, such as they would experience with an analytic approach, until their speech recognition skills improve.]

Since Ross' (2005) and Sweetow and Sabes' (2007b) publications, TigerSpeech and Cochlear Americas have upgraded *Sound and Beyond* to *Sound and WAY Beyond*, boasting new additions to the program. Additionally, TigerSpeech identifies on its website that the company has discontinued the program *Hearing Your Life* from Advanced Bionics (www.tigerspeech.com/tst_products.html). *Listening and Communication Enhancement (LACE)* has offered new research into their program since 2005, which may be valuable to a comparison of this nature. Finally, these two reviews were not inclined towards any particular type of device or user, exploring programming intended for hearing aid and cochlear implant recipients.

Olson and Canada (2010) completed a simple, user-friendly review of five programs:

- *Sound and WAY Beyond* from Cochlear Americas
- *The Listening Room (CLIX)* from Advanced Bionics
- *Seeing and Hearing Speech* from Sensimetrics
- *Soundscape* from Med-El

- *Speech Perception Assessment and Training System (SPATS)* from Communication Disorders Technology Inc.

They addressed such topics as:

- creators/marketers
- cost
- targeted areas for improvement
- analytic versus synthetic approach
- variety of tasks and levels within tasks
- feedback methods
- adaptation to client progress

While Olson and Canada (2010) provide an up-to-date and succinct summary of auditory training and the software programs that are available to consumers at the moment, they did not consider *Listening and Communication Enhancement (LACE)*, possibly because it is technically intended for hearing aid users and has not yet provided specialized programming for cochlear implant users (Sweetow & Sabes, 2007a). The summary provided by Olson and Canada (2010) covers significant breadth regarding the number of programs available, however, there is only a sentence or two of detail provided for each program. It provided a good introduction to available software, but this author remained unsatisfied with the depth of the information provided. Given that this author's intention is to offer an aide to the reader that potentially saves him or her the effort of completing further research him/herself and offers increased

confidence to make a purchasing decision after simply picking up one summary paper - there was still more work to be done.

The aim of this paper is to combine the information provided by, and build upon, the works of Ross (2005), Sweetow and Sabes (2007b), and Olson and Canada (2010), providing an up-to-date and more comprehensive summary. Additionally, this paper clearly cross-references what can be a confusing puzzle of researchers, creators, company names, and commercial program names. This author's goal is to provide a simple, but comprehensive, guide/summary for audiologists, speech therapists, and adult cochlear implant recipients who may be interested in accessing or suggesting an appropriate computer-based, home-based auditory training program. It will focus on exploring eight of the auditory training software programs available to the cochlear implant community today, providing a summary of major features that might assist a consumer in choosing the most appropriate program for his or her needs. The programs to be explored are:

- *Computer Assisted Speech Perception Testing and Training at the Sentence Level (CasperSent)* from Arthur Boothroyd
- *Listening And Communication Enhancement (LACE)* from Neurotone Inc.
- *ReadMyQuips* from Sense Synergy
- *Seeing and Hearing Speech* from Sensimetrics
- *Sound and WAY Beyond* from Cochlear Americas (from TigerSpeech, also known as Computer Aided Speech Training/CAST)
- *SoundScape* from Med-El
- *Speech Perception Assessment and Training System (SPATS)* from Communication Disorders Technology Inc.

- *The Listening Room* from Advanced Bionics

This paper includes *CasperSent*, created by Arthur Boothroyd. It was included in one of the above summaries (Sweetow and Sabes, 2007b) but not in the other two. Sweetow and Sabes (2007b) appear to have had a slightly different purpose (i.e., to provide a more research oriented report) from the other summaries. *CasperSent* may not have been included in the other summaries because it is not commercially available; however, this author believes that a clinician or cochlear implant recipient could gain access to a copy of this program if he or she felt it was the ideal program to meet his or her needs. This author was able to obtain a copy directly from the creator's staff, paying the shipping fees.

Listening and Communication Enhancement (LACE) has been included in this summary, despite it being intended for hearing aid users, because of the possibility for its application to the individual needs of a cochlear implant recipient. The creators stated that they were constructing a version incorporating training tasks for cochlear implant recipients (Sweetow & Sabes, 2007a). With the intention of being comprehensive, this author felt it may be remiss to leave *LACE* out of this report.

With the exception of *ReadMyQuips* (discussed in Boothroyd, 2010), all of the other programs were included in one or more of the three summaries noted above, thus it only made sense to include them here. *ReadMyQuips* is an extremely new program and has not yet been explored in many publications; therefore it was appropriate to cover it in this review.

Programs that were discussed in other publications (Bloom, 2004; Boothroyd, 2010; Olson and Canada, 2010; Ross, 2005; Sweetow and Sabes, 2007b) that will not be explored in this paper are:

Computer Assisted Tracking Simulation (CATS): The reader is encouraged to access Sweetow and Sabes (2007b) for a summary of this program. CATS is intended for adult cochlear implant users, but does not appear to be actively used by clinicians or commercially available at this time. The activities are also currently fully clinician led, though creators were exploring a self-administered version. Sweetow and Sabes (2007b) reported promising results from both pilot studies reviewed and from continued research underway by the creators.

MacAid: *MacAid* was created by Barbara Parker. It has not been included in this summary as it does not appear to be mainstream at this time. This program was intended for general auditory training, not specifically for cochlear implant users. Parker acknowledged (Bloom, 2004) that *MacAid* lacks the sophistication of *Listening and Communication Enhancement (LACE)*. Given *LACE* is active in current auditory training conversations and Parker reported that *LACE* is more sophisticated (Bloom, 2004), this author felt consideration of *LACE* sufficient.

Conversation Made Easy: *Conversation Made Easy* was created by Nancy Tye-Murray in the mid 1980s and showed great promise (Bloom, 2004; Ross, 2005). It is not highlighted in many publications that are more recent and does not appear to be a popular consideration at this time. Bloom (2004) reported interest from Nancy Tye-Murray in expanding the program; however, this author was unable to access more recent information on *Conversation Made Easy*. Lastly, this program was intended for general auditory training, not specifically for cochlear implant users, thus was not a priority for this exploration.

eARena: eARena is available from Siemens (www.siemens.com). Boothroyd (2010) mentions it briefly in his 2010 publication about formal training in aural rehabilitation; however, this author was unable to access any detailed program information on the website. This program is not widely mentioned; therefore, it was not pursued further.

The features to be discussed in this review are:

- creators, marketers
- the cost of purchasing the program
- demonstration versions available to help decision making
- ease of purchasing
- hardware and software requirements
- ease of use/how much computer literacy required
- programming for tablet or mp3 player use
- targeted areas for improvement
- analytic versus synthetic approach
- variety of tasks and levels within tasks
- feedback methods
- adaptation to client progress
- therapist involvement requirements
- recommended time commitment from client
- research studies, where applicable

Appendix A: “Publications Comparison Table” provides a table summarizing the programs and features explored by the three previous publications (Olson & Canada, 2010; Ross, 2005; Sweetow & Sabes, 2007b) and this paper. The list of features to be discussed in this paper includes topics from previous publications. There are also additional topics included (e.g., demonstration version available, ease of access/purchasing, computer literacy required, hardware and software requirements, programming for mobile devices such as mp3 players or tablet use) that this author felt may be important to the consumer and were a relatively simple inclusion to the project. This project is presented in the form of text and discussion for those interested in the full depth of information. Appendix B: “Program Comparison Table” includes a table summarizing the programs and features described in this report for a quick perspective.

METHOD

In July 2011, a literature search of three major databases related to speech pathology, audiology, and health care in general was the starting point for this project. The databases accessed are summarized in Table 1.

Table 1: Databases Searched and Results

Database	Results
CINAHL	11 discovered
ComDisDome	2 repeated, others not helpful
Medline	2 new, many repeated

A variety of search terms were used, depending on database, and in an attempt to explore all avenues. General search terms (i.e., auditory training, software, cochlear implant, adult, etc.) yielded repetitive results very quickly. By the time these major databases were searched, all results were repetitious and yielded only 10-15 relevant publications.

Searching the Internet resulted in the most useful information. It was this tool that provided the easiest and most direct method to accessing information about specific programs. This author used knowledge about program names, even partial, to search for related websites. These sites provided informational brochures, marketing information, access to publications, program demonstrations, and sometimes access to the entire program.

Searching general terms like “auditory training” on Google yielded results for the TigerSpeech Technology website and programs. This was a key discovery as none of the

publications that had been found up to this point, connected *Sound and WAY Beyond* to TigerSpeech Technology. They all talked about the House Ear Institute, Computer Assisted Speech Training (CAST) and Qian-Jie Fu, but not TigerSpeech Technology (Olson & Canada, 2010; Ross, 2005; Sweetow & Sabes, 2007b). Additionally, this website provided a demonstration version of *Sound and Way Beyond*, which was not offered via the Cochlear Americas website. Lastly, the TigerSpeech Technology website was able to provide information useful to discern software status. Explanation will follow in "Results" section.

This process was like piecing together a puzzle of creators, formal names for programs, marketers, and the commercial name of programs. Armed with a much clearer understanding of the state of affairs in computerized auditory training, this author returned to the databases previously searched. This time specific bodies of work, based on reference lists from websites and from publications found to date, were searched out. These searches also yielded other publications that proved useful. This process was repeated as new resources provided a growing list of possible helpful references.

Google Scholar proved to be a dependable source of specific publications that were difficult to find at any other online source and would have required the author to visit specific libraries to obtain a copy of the journal.

This author explored eight programs in greater depth using a variety of means to do so (additional programs, mentioned above, were not explored in further detail). This information is detailed in Table 2.

Table 2: Programs and Methods Used in Review

Program	Methods Used for Reviewing (ordered from most to least helpful within each cell)
CasperSent	• entire program provided to author by creator • publications • website
LACE	• publications • demonstration version • website
ReadMyQuips	• website • demonstration version • publications
Seeing and Hearing Speech	• website • publications (limited)
Sound and WAY Beyond	• publications • Cochlear Americas website • TigerSpeech Technology website • demonstration version
SoundScape	• website - full program available
SPATS	• publications • website
The Listening Room	• website - full program available • publications (limited)

The criteria for exploring the programs were outlined based on a compilation of characteristics from authors of previous reviews, in addition to new items of interest chosen by this author (i.e., use of program with mobile devices, availability of trial demonstrations, clarifying the relationship between researchers and marketers). Please refer to Appendix A:

"Publications Comparison Table" to review the features included in previous reviews compared to the current review.

A working spreadsheet was created listing all the programs on one axis and the features on the other axis. As sources were reviewed using the methods listed in Table 2, characteristics were recorded in the spreadsheet. This process allowed for detailed exploration of most programs, while forming a big picture view of this topic. The information was summarized in text form below, see "Results". A table was also created for quick access to information, see Appendix B: "Program Comparison Table". This table (Appendix B) allows the reader to find for a particular feature and scan the programs to see if they offer this feature. Conversely, one may also find a program of interest and scan to ensure it includes the desired features. If it does not, one may compare to programs that do have that feature in one quick glance.

RESULTS

Computer Assisted Speech Perception Testing and Training: Sentence Level (CasperSent)

CasperSent is intended for individuals who have lost perceptual abilities in the areas of hearing or have reduced ability in compensatory skill areas such as lipreading (Boothroyd, 2008). The focus is on auditory, visual, and auditory-visual speech perception training at the sentence level (Boothroyd, 2008), a completely synthetic approach. Improvement in perception is expected simply as a factor of increasing total time spent on the task (Boothroyd, 2008). The goal is to improve perceptual skill by providing sensory information (i.e., video or sound recording of people talking) and contextual information (i.e., topic of sentences), paired with the user's knowledge (i.e., words and phrases common to topic, knowledge of the world) and skill (i.e., ability to combine all the above items to make inferences about the statement) to achieve improvement in overall perception (Boothroyd, 2008).

The program runs on a standard laptop or computer, PC or Apple, as long as it is equipped with Microsoft Windows and a CD (for software installation) and DVD drive (to play or transfer the speech files). The sentences are presented in sets of 12, and there are 60 sets. There are 12 topics that stay common from set to set. Sentences range from 3-14 words and are split equally three ways between statements, questions, and commands. The sentences are spoken by three different talkers. Two of the speakers are recorded at 0, 45, and 90 degree angles from the camera (Boothroyd, 2008). The user can choose to have the topic displayed or not. The user can choose to have the stimulus presented as visual only, auditory only, or audio-visual combined. The individual listens/watches the stimulus and chooses the words he or she

hears. The user can choose to have no feedback, partial feedback (i.e., just words correct followed by a second attempt), or full text shown after presentation. There are no options to add background noise within the program; the user would have to find an external source (i.e., audiometer with background noise playing in the sound field). Perhaps if an individual were practicing this program at home and wanted external background noise, it may be quite a natural thing to create (e.g., television, radio, people in room).

CasperSent is not commercially available at this time; however, individuals can access the manual and samples of the program from the creator's website (www.arthurboothroyd.com). Boothroyd (2008) requests that individuals seeking a full program make contact with Dr. Matthew Bakke, director of the Gallaudet University Rehabilitation Engineering and Research Center at matthew.bakke@gallaudet.edu. This author paid only the shipping charges to obtain a copy of the full program.

CasperSent can be used independently, with a helper, or with a clinician (though the assisted approaches will require a second monitor). Use of the program does require sufficient comfort with computers to download the material from the CD and DVDs. Using the program may be overwhelming for some due to the settings that can be controlled and adjusted manually; however, for the individual who is computer literate, inclined to detail or research, and desiring skill development in sentence perception and/or lipreading, this may be a viable option to pursue.

Research Studies. There are publications discussing the characteristics and use of the program (Boothroyd, 2008; Sweetow and Sabes, 2007b); however, this author was unable to

find publications detailing research study results regarding the efficacy of *CasperSent* for aural rehabilitation.

Listening And Communication Enhancement (LACE)

Listening And Communication Enhancement (LACE) is intended for hearing aid users but may be appropriate for any individual wishing to improve his or her listening skills (Sweetow and Sabes, 2006). *LACE* incorporates elements of both an analytic and a synthetic approach; however, Robert Sweetow is a proponent of building communication skills (Pallarito, 2011; Sweetow and Sabes, 2007a) and subsequently *LACE* may be more focused on this approach (Miller et al., 2008).

LACE is offered by Neurotone Inc. (www.neurotone.com). The program can be purchased online as a DVD ($99US), a package containing both CD-ROM and DVD ($149US), or as a download and registration code that does not include a DVD ($99US). At the time of this investigation, there was a sale on the download and registration code product, so a consumer may wish to look for product sales. There is a special site for professionals to purchase resources, which may have different prices than shown on the general consumer site. There were no other methods for ordering such as phone or mail, but an interested party could likely phone, mail, or email the company if they needed assistance ordering the product. There are also participating *LACE* professionals (participating local audiology service providers) who would be able to assist an individual in obtaining a copy of the program and/or using the program (though there may be a fee involved). There is also a “Frequently Asked Questions” section on the website that may be helpful when troubleshooting.

LACE is one of the few providers who offers their program for both PC and Apple computers with standard system requirements, including free demonstration downloads for both formats (Sweetow and Sabes, 2007b; www.neurotone.com). The trial versions are limited to two examples per task and a sample chart for data collection, but it is sufficient to gain an understanding of the way the tasks are completed and how easy the program is to use. The instructions are clear, the on-screen buttons offering options are illuminated and may be selected; when not illuminated the buttons are inactive. There is also an option to use keyboard keys to activate buttons instead of a mouse, if a user prefers that access method. There is no internet access required to use the program from the CD-ROM. High speed internet is required to purchase the downloaded version of the program or to access the website for support.

Sweetow and Sabes (2006, 2007a, 2007b) report that *LACE* targets the broad areas of auditory memory, speed of processing, use of context, and interactive communication strategies. The activities provide immediate feedback to the user based on the user's subjective report of whether he or she heard the sentence correctly. The exercise will adapt the difficulty based on the user's feedback. Specifically it uses "Degraded Speech" tasks to build skill for listening to fast talkers, listening in background noise, and for situations involving a competing speaker. "Target Word" tasks build skill with auditory memory and speed of processing. "Missing Word" tasks build speed of processing and use of contextual and linguistic cues to fill in unheard words. This is the only activity in the program that is not adaptive to the user's success or difficulty with the stimuli. Between tasks, a "Helpful Hint" for interactive communication may pop onto the screen. These are short text additions that discuss strategies such as realistic expectations, managing the acoustical environment, assertive listening skills, care and maintenance of hearing aids, and assistive listening devices. There is a chart presented

when the task is over and all stimuli have been completed. These results can be electronically sent to a therapist if this is the arrangement the user has decided on.

One additional feature of the *LACE* program is that multiple users can use the program if they obtain additional registration codes, which is cheaper than purchasing an individual program. Also, the program can be used on more than one computer. The user chooses the "Enable Mobility" option when setting up his or her program, to use the program on multiple computers. The *LACE* program was originally intended for hearing aid users only; though the creators have expressed intent to create additional program elements that meet specific needs of cochlear implant users (Sweetow and Sabes, 2007b).

Sweetow and Sabes (2007a, 2007b) recommend the program be used for 30 minutes per day, 5 days per week, for 4 weeks. For earlier versions of the CD-ROM, that concludes the programming. *LACE 4* now allows the user to continue past this point. An update to *LACE 4*, if necessary, is provided free to the consumer by Neurotone Inc. The DVD can also be used repeatedly, whenever the user feels he or she needs some practice (www.neurotone.com).

Research Studies. Sweetow and Sabes (2006, 2007a) offer two publications summarizing controlled study results comparing hearing aid users who received auditory training using *LACE* with hearing aid users who received no auditory training. Subjects who received auditory training with *LACE* showed significant improvement in Speech In Babble, Competing Speaker, Time Compressed Speech, and Auditory Memory tasks. Improvements lasted through to a one-month follow-up, but were not investigated at longer intervals. Sabes and Sweetow (2007) looked at factors for determining prognosis in auditory rehabilitation. They reported that, generally, clients with most to gain, gain the most, but almost all users make some gain whether

it be on objective or subjective measures. Sabes and Sweetow (2007) highlighted motivation to improve as the most critical factor when determining prognosis in any individual cochlear implant recipient.

Martin (2007) completed a study using *LACE* with hearing aid users. She compared hearing aid return rates for hearing aid users who received auditory training with *LACE* versus hearing aid users who did not receive auditory training. Martin found that a patient was four times more likely to return a hearing aid when he or she did not receive the auditory training with *LACE*.

ReadMyQuips

ReadMyQuips has only been recently added to the computer-assisted programs arsenal (Boothroyd, 2010). This program, provided by Sense Synergy (http://www.sensesynergy.com/readmyquips), has a trial version of the program available on the website. The program has the user fill in a crossword puzzle from identification of missing words in a video speech message of a "quip". The sentence, with spaces for blank words, is positioned at the bottom of the screen. The user watches/listens to the video stimuli and types the missing words into the boxes. *ReadMyQuips* uses a fully synthetic approach to training. The program provides feedback regarding number of points achieved with each turn taken. With increased correct responses, the background noise increases for subsequent quotes. If responses are incorrect, the background noise is decreased until the user is successful. There is also an option to increase the difficulty manually (i.e., the loudness of background noise) if the user chooses. The video presentation of the stimuli offers opportunity to build speechreading skills in addition to speech

perception skills. The program is intended to remediate hearing aid users' difficulties understanding speech in background noise, in an enjoyable and interactive way. There is no evidence to support or deter a cochlear implant user from interacting with this program. The full version of the program can be purchased online at http://www.sensesynergy.com/readmyquips for ($99.99US). This program can be used on any computer that has Internet access; this includes tablets such as the iPad assuming there is access to wi-fi Internet. On the Sense Synergy website, Ross (retrieved 2012, March 2) also provides an article discussing how to make the most of a program like *ReadMyQuips*.

Research Studies. Levitt (2011; and a second article retrieved 2012, March 2 from Sense Synergy website) completed a study using *ReadMyQuips.* Improvements in understanding speech in noise were judged from pre- and post-training measures. Levitt reported that most subjects experienced a 30% improvement, with some subjects experiencing as much as a 50% improvement in their ability to hear speech in noise. Levitt stated that the subjects reported enjoying the program; that it was designed to be entertaining to encourage more time spent on task and maintain interest.

Seeing and Hearing Speech

Seeing and Hearing Speech is marketed by Sensimetrics Corporation. *Seeing and Hearing Speech* states it provides well-organized "lessons in lipreading and listening" (www.seeingspeech.com). There is no demonstration version available to the user. An interested individual can explore the company's description of some of the features and watch a

short clip of each speaker to assess quality of recording on the website (www.seeingspeech.com), but there is no interactive component to explore. They claim to target vowels, consonants, connected speech, and difficult listening situations. Based on this summary, this author would assume this program to use both analytic and synthetic approaches to the training offered in *Seeing and Hearing Speech*. The website states that the lessons offer the user the option to train using both auditory and visual information, just auditory information, or just visual information. The user can control the rate of speech, add noise, and listen to multiple talkers. There is an option to save the results. This program does appear to place an emphasis on building skill in lipreading to enhance communication for hearing impaired individuals. The full CD-ROM can be purchased at the same site, by phone, mail, or fax for $85US.

The website clearly outlines the computer requirements for use of the program which are standard to most computers. *Seeing and Hearing Speech* does not offer any option for a program that can be used on Apple products, actually stating in their "Frequently Asked Questions" section that they have discontinued software versions for Apple products due to ongoing difficulties (www.seeingspeech.com). Ease of use is difficult to ascertain from the marketing on the website. There is an endorsement from a well-known audiology professional stating how easy it is to use, but this is the only testimonial. No Internet connection is required to use the CD-ROM. There is no option to use this program on other devices such as tablets or mp3 players.

Research Studies. This author was unable to find research studies aimed at determining the efficacy of *Seeing and Hearing Speech*.

Sound and WAY Beyond

Sound and WAY Beyond targets areas of pure tone, vowel and consonant discrimination, male versus female voice discrimination, environmental sounds, identifying words in sentences and identifying complete sentences (e.g., from a closed set of choices or by the user typing what he or she heard). There are modules targeting telephone use (i.e., word recognition as it would sound through a telephone) and music recognition and appreciation (i.e., musical note and pattern recognition; familiar songs). *Sound and WAY Beyond* offers an analytic and synthetic approach to training. The research from Fu et al. (2005) and Fu and Galvin (2007a, 2007b) displayed a strong focus on the analytic training and subsequent results; however, Fu and Galvin (2007a, 2007b) address how their program supports progress from a synthetic approach as well.

The creators chose targets that are often specifically problematic for cochlear implant users (Fu & Galvin, 2007a, 2007b). Within each of the modules there are levels of difficulty, which add background noise, increase rate, or add complexity to the stimuli. There is a timer at the bottom of the screen that can add another element of feedback, by tracking response time, for the user. The user makes choices by clicking on the appropriate area with the mouse. There are options to stop or replay the stimulus. The user receives immediate feedback on the accuracy of his or her choice by displaying a “thumbs up or down” symbol paired with the text “That is/is not correct”. The program then replays the stimulus and the user’s choice for comparison. This provides both visual and auditory feedback (Fu & Galvin, 2007a, 2007b). Fu and Galvin also report the added benefit of individualized programming, meaning the level of difficulty will be automatically adjusted depending on the user’s performance during a task. Once tasks are complete the program will suggest tips to improve performance and/or suggest the most appropriate training level for the individual (Fu & Galvin, 2007a, 2007b). *Sound and*

WAY Beyond is manufactured by TigerSpeech Technology for Cochlear Americas. It is one version of their Computer Assisted Speech Training (CAST) programming. A trial version is available at www.tigerspeech.com. This trial offers exploration of all activities and five examples of each level within the activity, which is sufficient to understand the basic offerings of this auditory training program.

The full program can be purchased from the Cochlear Americas website (www.cochlearamericas.com/store) or by telephone. The program comes as an interactive CD-ROM. The cost is $99US for recipients of a Cochlear Americas cochlear implant, clinicians, and educators. The cost for other cochlear implant recipients is $290US.

This program is intended for home use by a cochlear implant recipient, thus clinician involvement is not required. However, the data can be monitored and shared with a clinician if the client chooses. There is no recommended time commitment offered by the provider. Fu and Galvin (2007a, 2007b) suggested that any practice is better than none at all, and that intensive training is not necessarily preferable to regular practice within a reasonable time period.

The website also outlines the computer requirements necessary to use this program, which are standard for most computers or laptops. If the client uses an Apple computer, there are specific requirements to make it possible to use *Sound and WAY Beyond* on this brand of computer and this should be investigated before purchasing. Getting started with the program is simple, requiring only basic comfort with computers. Once the program is installed, it is very easy to use and navigate through the program. There is no internet connection required to use the program (internet connection is required for the trial download). Directions are explicit at each step, taking the user through the options and where to click depending on his or her

choice. There is no option to use this program on devices such as tablets or mp3 players at this time.

Research Studies. Fu et al. (2005) reported significant improvements in all phoneme discrimination tasks with regular training using Computer Assisted Speech Training (CAST) (which is the larger research program that provides the foundation for the commercial program *Sound and WAY Beyond* provided by Cochlear Americas). Fu and Galvin (2007b) conducted a study that had subjects train at 1 hour per day, 5 days per week, for one month or longer. This study yielded significant improvements in all phoneme discrimination. Anecdotally, patients report better perception and appreciation (i.e., able to pick out singer's voice in music). Also in 2007(a), Fu and Galvin summarized their studies to date, which showed generalization of skills learned during training with Computer Assisted Speech Training (CAST) to different speech tests and listening environments. They highlighted that the cost of software is extremely low in comparison to cost of the cochlear implant device and that a user may not realize the full benefit of the cochlear implant device until they experience targeted speech training. Their studies showed that cochlear implant users who did not receive auditory training made only 20% of the gains that an individual with targeted auditory training was able to make. Finally, Fu and Galvin suggested that only moderate amounts of training are required to achieve significant results.

SoundScape

SoundScape is a FREE online auditory training program provided by Med-El (www.medel.com/us/show4/index/id/255/title/SoundScape). It offers one activity for adults called a "Sentence Matrix" (there are other activities that are intended for children and adolescents but could be used by an adult if an individual found them useful). This activity is based on a synthetic approach to training (the other activities for children may include an analytic approach but this is beyond the scope of this discussion). The "Sentence Matrix" activity targets listening in noise, speed of processing, and auditory memory. It does so by offering the individual choices regarding the gender of the talkers (male, female, both), the amount of background noise (none, some, more), the rate of speech (slow, normal, fast), and the number of sentences presented (10, 25, 50). The user then listens to the stimulus and chooses the words he or she heard from a matrix of choices provided. The program shows which were correct and which were not. The user can listen to the sentence again, though there is no opportunity to correct choices for feedback at this time. When the user is done the task, a total percentage correct is calculated, with a fractional (e.g., 7/10) breakdown below each column (beginning, middle, and final words in sentence) to help the user identify if the location of a word within a sentence affects his or her ability to correctly identify the word. If scores over the duration of the training time are desired, they need to be tracked by the user because the program does not track the data. Though the program is interactive, it does not make adjustments to difficulty as the user progresses through the stimuli. It is quite simple for the user to go back and change the difficulty level, if they are able to identify which areas might best be adjusted.

This program is very simple to use. Use of this program does require access to Internet for the duration of the practice session. It would work on a tablet that had internet access and Flash Player capabilities. The most challenging part of using this program may be navigating the website to find the *SoundScape* program. When searching using Google, just searching "Med-El" (as the program name was not known at the time of initial search) resulted in having to navigate the website until *SoundScape* was found under the heading "User Support". Just using "SoundScape" in a Google search engine did not result in the *SoundScape* program high on the list of results. The best search term was "Med-El and SoundScape". The direct link to *SoundScape* was also provided in the first sentence of this section in order to save time for the reader.

This program is intended for independent use; no clinician involvement is required. The *SoundScape* webpage does not suggest any recommended practice timelines. The website provides many print resources with ideas for communication improvement.

Research Studies. This author was unable to find research studies aimed at determining the efficacy of *SoundScape*.

Speech Perception Assessment and Training System (SPATS)

The Speech Perception Assessment and Training System (SPATS) focuses on improving an individual's perception at the sound level, syllable level, and sentence level (Miller et al, 2008). Miller et al. reported that targeting the sound and syllable level of speech helps hearing aid users and cochlear implant users to more accurately identify speech sounds using their devices.

Sentence level stimuli train the individual to use contextual cues to identify all parts of the sentence and comprehend its meaning. Miller et al. reported intentionally using both an analytic approach and a synthetic approach within one training activity with *SPATS* to keep the user challenged.

This program is distributed by Communication Disorders Technology Inc. (www.comdistec.com) and is currently available only through "certified" clinics. Olson and Canada (2010) reported that this program costs $150 for a one year license. Audiologists are specially trained and certified to administer the program and it is recommended that the individual use the program in conjunction with a therapist for the first 8-10 hours after which time they should be able to continue at home independently. Regular appointments with the therapist are recommended as the individual progresses through the program. Once the 8-10 hours of work with the clinician has been completed, a laptop is sufficient to use the program at home. Individuals should discuss specific requirements with the clinician should they be interested in using *SPATS*. The creators recommended 15-40 minutes of practice over several weeks in order to achieve optimal results.

Research Studies. Miller et al. (2008) completed efficacy studies for *SPATS* yielding results (no specific numbers shared with the reader) that led the authors to claim successful application with hearing aid users and cochlear implant users.

The Listening Room (CLIX)

The Listening Room is a fully online FREE auditory training program offered through the Advanced Bionics website (http://www.hearingjourney.com/Listening_Room/preview.cfm?langid=1). The program was developed and illustrated by Dave Sindrey, M.Cl.Sc. Cert. AVT, along with contributions from Liam Jowahir-Sindrey, Chris Barton, MM, MT-BC and Amy McConkey Robbins, MS, CCC-SLP.

There is no cost to access this program. An interested user needs only to have Internet access and an email address to create an account. Internet is required to access the resources initially, but with many activities offering downloadable materials, a user can prepare for times when Internet access may not be possible. The website (www.hearingjourney.com/Listening_Room/Teens_and_Adults/Listening_Gym/index.cfm?langid=1) offers sound and speech discrimination, strengthening listening skills in challenging environments, improving listening on the telephone, and appreciating music. This program uses both analytic and synthetic approaches to auditory training.

The Listening Room program uses three main types of programming: “CLIX”, “thumbprints”, and “paper trails”. “CLIX” activities are best suited to a PC personal computer (it is not currently compatible with Apple products). These activities are downloaded from *The Listening Room* website. They are interactive activities that can be completed by the user independently by choosing to listen to a recorded voice presenting the stimulus word or by having a familiar voice (i.e., listening coach, family member, friend) present the stimulus word. The activities span from warm-up/beginner to olympic/advanced. There are more sub-levels (“20lbs - 100lbs”; levels are paired with a visual depiction of light to heavy barbells) within each of the general ability levels that focus on specific skills categories (e.g., different syllable

number, final place consonants). The program encourages the user to take a placement test when he or she is unsure of the sub-level at which to start. The user listens to the stimulus (there is an option to repeat the stimulus if necessary), clicks with a mouse on his or her choice (which appears purple), and is provided feedback with the correct choice highlighted in green and simultaneous repetition of the stimulus. “CLIX” allows the user to log in and track test scores and/or activity trial scores. The activity trials may be tracked by total trials completed, progression of scores from first to last sessions, and the current session’s scores. “Thumbprints” can be downloaded to a tablet or mp3 player for use when mobile. The user listens to the stimulus; the screen shows four choices either in quadrants on the screen or colour-coded. The user can then touch his or her choice and wait to see if he or she was correct. “Thumbprints” is not technically interactive, meaning it does not receive the user’s choice in any way and does not respond accordingly. It will move forward regardless of the user’s behaviour. A listener must choose to engage with the activity in his or her own manner. Printable paper versions (”paper trails”) of the activities can be printed for use with a Listening Coach who can administer and participate in the practice items with the user, providing feedback. Skills are developed in target areas using activities broadly titled “Conversations”, “Discrimination Activities”, “Making the Connection”, “Music Appreciation”, “Speech Tracking”, and “Telephone”. Each category may use one or all of the programming options, “CLIX”, “thumbprints”, and/or “paper trails”, to offer opportunities to build skill.

“Conversations” provides sentences that are common greetings and common questions. In the “thumbprints” activity there is a set of four options to choose from. There activities are made more engaging by having the options colour-coded. The user can touch the colour he or she chooses, but the choice and the feedback is not actually interactive. The program follows its

prescribed path, despite user response. There are "paper trails" activities to use with a Listening Coach within this activity.

"Discrimination Activities" offers "CLIX", "thumbprints", and "paper trails" options. The "thumbprints" feature offers a choice of activities that increase in difficulty, but again, this is not interactive, so a listener must judge which difficulty level to attempt. There are four choices for each stimuli; the difficulty is prescribed by the type of task, not the number of items in the set.

"Making the Connection Workbook" offers a selection of sound tracks focused on the areas of types of sounds (i.e., environmental, speech), pattern perception (i.e., number of syllables in word), and categories (i.e., food, colours). These tracks can be listened to directly from the site or downloaded to a computer for ongoing use when Internet is not available. The exercises have printable score sheets for the user to make his or her selections and separate printable answer sheets.

"Music Appreciation" offers activities for use directly from the website, or via "thumbprints", and through use of "CLIX". These activities focus on styles of music (i.e., jazz), famous tunes (i.e., Here Comes the Bride), and instrument solos (i.e., trumpet). Advanced Bionics also offers its members a free musical program called "Musical Atmospheres".

"Speech Tracking" exercises are offered as "thumbprints" and "paper trails". They allow you to listen to a passage, follow along with a text version, and identify the word at which the speaker stopped.

"Telephone Practice" offers a "CLIX" activity and a "paper trails" activity. The "paper trails" activity allows the user to print a passage, then phone a number provided, to listen to a person read the passage; the user can follow along on his or her printed version.

Within each of these activities *The Listening Room* also provides tips or hints documents that a user can read, download, and print if desired.

The Listening Room program requires the user to be comfortable using the Internet, in addition to downloading files, saving files, and transferring them to mp3 players if desired. The "thumbprint" activities are not technically demanding to participate in once accessed, particularly because they do not require interaction with the program. "CLIX" requires some direction from the user (i.e., making choice of levels) but is otherwise visually clean and easy to use. There is no recommended time commitment from the providers.

Research Studies. This author was unable to find research studies aiming at determining the efficacy of *The Listening Room*. However, Dave Sindrey, named as one of the creators, has significant background in aural rehabilitation and materials for use in therapy.

CONCLUSION

After exploration into auditory training for adult cochlear implant recipients, there is one overwhelming message apparent to this author: the decision for provision of auditory training, and type of auditory training, must be considered on an individual basis.

The support for auditory training as one portion a comprehensive program for aural rehabilitation is present in the literature (Abrams, 2010; Bloom, 2004; Boothroyd, 2007, 2008, 2010; Chisholm et al. 2004; Fu et al. 2005; Fu & Galvin, 2007a, 2007b; Hull, 2011; Martin, 2007; McCarthy & Schau, 2008; Miller et al., 2008; Olson & Canada, 2010; Pallarito, 2011; Ross, 2005; Sabes & Sweetow, 2007; Sweetow & Sabes, 2006, 2007a, 2007b, 2008, 2010). There are studies to support that patient satisfaction with a cochlear implant device can be increased with training (Fu & Galvin, 2007a; Stacey et al. 2010). Wayner (2005) and Martin (2007) have each completed studies showing that return rates of hearing aids decrease when auditory training is part of the rehabilitation protocol. Cochlear implant recipients cannot return their cochlear implant, but they can choose not to use the device. Does experience with auditory training decrease the likelihood that a cochlear implant recipient will not use his or her device? Would it be more likely that the individual increases skill when communicating using the device, as a result of exposure to auditory training? There are researchers who believe this last statement is true, and dedicate much of their energy to providing supporting information to increase use of auditory training in rehabilitation (Boothroyd, 2008; Fu et al., 2005; Fu & Galvin, 2007a, 2007b).

Clinicians and cochlear implant recipients may first need to have open dialogue regarding the client's interest in participating in some format of auditory training. This author's impression of the literature was that most researchers feel that there are benefits to clients as a

result of auditory training, even if statistical significance is not consistently achieved (Abrams, 2010; Boothroyd, 2010; Chisholm et al., 2004; Stacey et al., 2010; Sweetow and Sabes, 2007a). If a client is motivated to build his or her skills in the areas of listening and communication, then a format should be chosen based on what is available to the client, what fits best with his or her listening and communication needs, financial needs, style of learning, and lifestyle.

This review focused specifically on the area of home-based, computerized auditory training for adult cochlear implant recipients. This format for auditory training, as opposed to direct individual or group intervention, has sparked a resurgence in the interest and research surrounding auditory training (Bloom, 2004). Some professionals within the audiology community are embracing home-based, computerized auditory training as a feasible solution to the lack of resources (i.e., education, clinical guidelines, manpower) plaguing clinics across North America (Boothroyd, 2010; Fu & Galvin, 2007a; Pallarito, 2011; Sweetow & Sabes, 2006, 2007a, 2007b, 2010).

Eight home-based, software programs were reviewed in the previous section. These programs were reviewed based on which programs appeared to be of current interest in the auditory training community. The programs' features were explored in such a manner as to save the busy clinician, the new clinician, or the overwhelmed cochlear implant recipient the time to research these programs for themselves. This author hopes this guide proves to be a useful tool when making decisions surrounding computerized auditory training program purchases.

Choosing a computer software program for auditory training at home is a very individual decision. This author's impression is that a user needs to carefully consider, and perhaps discuss with a clinician, what his or her strengths and areas for improvement are. For example, Fu & Galvin (2007b) feel strongly that a new cochlear implant user, or one with poor skills in

recognizing parts of speech, would benefit most from a program that offers analytical, drill-like, phoneme recognition activities as a basis for learning. They support a synthetic approach later as the user builds skill, becomes more proficient at identifying speech, and requires additional challenges (i.e., background noise, competing speakers). Each program offers a slightly different focus and reflects a philosophy about how to keep the user motivated to complete the tasks and subsequently improving his or her skills. For example, *Sound and WAY Beyond*, *SPATS,* and *The Listening Room/CLIX* have a stronger basis in phoneme discrimination and slowly build to sentence level challenges and music recognition. The programs are more prescribed and offer guidance on next steps. This might be best for the less confident cochlear implant user, who continues to struggle with discriminating speech sounds consistently. A user who is a well-established communicator in one-to-one situations or quiet environments, but struggles when there is background noise or competing speakers may find programs such as *LACE*, *SoundScape*, and *ReadMyQuips* more focused on their needs. A subset of individuals may feel that they need to build skill in a compensatory area such as speechreading in order to be a better communicator. For these individuals, one might point them in the direction of *CasperSent*, *Seeing and Hearing Speech*, or *ReadMyQuips*, which each incorporate a visual component to the program.

Another necessary consideration is cost of purchasing the program. This consideration becomes even more important when it is considered within the context of motivation, commitment to practicing regularly, and interest/enjoyment with the program. The user may not be convinced that this approach will help him or her. Perhaps the individual cannot be sure if he or she is disciplined enough to initiate practice. An individual may be hesitant to invest if he or she has concerns about liking the computer-based format for training. This author feels that

there may be two very simple solutions to these challenges. First, many programs offer a demonstration version of the program. A trial experience may answer all the user's questions about a program. Second, there are good, FREE programs on the market! Try these options first! The free programs may be sufficient to meet the needs of the user. If the free programs are not sufficient, the experience will likely start to clarify the areas of strength, areas of need, if interactive and adaptive programming is preferred, amount of feedback needed, if a clinician will play a role at all, and preferential activity types. Then the user can make a more educated decision regarding where to invest money.

As Cameron (1996) outlined, having ongoing, friendly dialogue with a clinician to ensure a cochlear implant recipient understands why a program of this nature is recommended in his or her individual situation and what possible benefits may ensue, will encourage increased compliance and dedication to using the program. Perhaps if a cochlear implant recipient is an active decision maker along the route taken to design his or her home-based computerized auditory training experience, this experience will increase commitment to practice with the computer program. As improvement in skill follows and satisfaction increases, the client will be naturally reinforced to use the program. The clinician may experience similar reinforcement and continue to recommend this type of intervention. This author has done a large portion of the background investigation, with an understanding of how busy clinicians are and how overwhelming these decisions can be for cochlear implant users. At some point, clinicians just have to integrate recommending home-based, computerized auditory training into their protocol, where appropriate, even if only for a trial period. A true evaluation of how this approach to auditory training realistically fits into the clinician's protocol cannot be achieved until it is tried in a natural setting. Clinicians are busy, change is hard, new protocols aren't

guaranteed to work perfectly - but imagine the results if these programs achieved all that the researchers hope. Better service delivery, happier clients, clinicians who feel more effective - a worthy endeavour.

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Appendix A: Publications Comparison Table

	Ross, 2005	Sweetow & Henderson Sabes, 2007	Olson & Canada, 2011	Miller et al., 2011 (Current Paper)
Programs Reviewed	• *Sound and Beyond* • *Seeing and Hearing Speech* • *Listening and Communication Enhancement (LACE)* • *Conversations Made Easy*	• *Sound and Beyond* • *CATS* • *Listening and Communication Enhancement (LACE)* • *CasperSent*	• *Sound and WAY Beyond* • *Seeing and Hearing Speech* • *Listening and Communication Enhancement (LACE)* • *The Listening Room (CLIX)* • *SoundScape* • *SPATS*	• *Sound and WAY Beyond* • *Seeing and Hearing Speech* • *Listening and Communication Enhancement (LACE)* • *The Listening Room (CLIX)* • *SoundScape* • *SPATS* • *CasperSent* • *ReadMyQuips*

Appendix A: Publications Comparison Table

	Ross, 2005	Sweetow & Henderson Sabes, 2007	Olson & Canada, 2011	Miller et al., 2011 (Current Paper)
Features Explored	• creators, marketers • cost • targeted areas • tasks/levels • feedback methods • adaptability • therapist involvement • time commitment • research studies	• creators, marketers • computer • requirements • targeted areas • tasks/levels • analytic versus synthetic • feedback methods • adaptability • therapist involvement • research studies	• creators, marketers • cost • targeted areas • analytic versus synthetic • tasks/levels • feedback methods • adaptability	• creators, marketers • cost • demonstration versions • ease of purchase • computer requirements • ease of use • tablet or mp3 player use • targeted areas • analytic versus synthetic • tasks/levels • feedback methods • adaptability • therapist involvement • time commitment • research studies

Appendix B: Program Comparison Table

	CasperSent	LACE	Read My Quips	Seeing and Hearing Speech	Sound and WAY Beyond	Sound Scape	SPATS	The Listening Room
Intended for use with hearing aid		x	x	x			x	
Intended for use with cochlear implant	x			x	x	x	x	x
Cost	Available only by special request, must pay shipping costs	$99, DVD only or download and registration number; $149 for DVD and CD-ROM	$99.99	$85	$99 for Cochlear recipient, clinicians, educators; $290 for other implant recipients	FREE	Available only through certified clinics; $150 (Olson & Canada, 2010)	FREE
Demo version available	x	x	x	x	x	x		x
Ease of access to purchase		x	x	x	x	x		x
Requires standard hardware	x	x	x	x	x	x	x	x
Tablet or mp3 options			x					x

Appendix B: Program Comparison Table

	CasperSent	LACE	Read My Quips	Seeing and Hearing Speech	Sound and WAY Beyond	Sound Scape	SPATS	The Listening Room
Home-based	x	x	x	x	x	x	After sessions with therapist	x
Ease of use/ Computer Literacy		x	x	x	x	x	x	x
Interactive	x	x	x	x	x	x	x	x
Interesting (challenging), but manageable (within user skill level)	x	x	x	x	x	x	x	x
Adaptive to client progress		x	x		x		x	
Listening training/ Repair Strategies		x			x	x		x
Visual stimulus/ Lipreading option	x		x	x				
Feedback	x	x	x	x	x	x	x	x
Progress Measurements	x	x		x	x		x	x

Appendix B: Program Comparison Table

	CasperSent	LACE	Read My Quips	Seeing and Hearing Speech	Sound and WAY Beyond	Sound Scape	SPATS	The Listening Room
Remote Access		x						
Therapist involvement required							x *only initially	
Manufacturers provide a recommended time commitment		x			x		x	
Synthetic (S) / Analytic (A) / Both (B)	S	B	S	B	B	S	B	B
Targeted areas of improvement:								
vowels				x	x		x	x
consonants				x	x		x	x
connected speech	x	x		x	x	x	x	x
music					x			x
telephone					x			x

Appendix B: Program Comparison Table

	CasperSent	LACE	Read My Quips	Seeing and Hearing Speech	Sound and WAY Beyond	Sound Scape	SPATS	The Listening Room
background noise/ multi-talker		x	x	x	x	x	x	x
lipreading	x		x	x				
variety of speakers	x	x	x	x	x	x	x	x
rate of speaker		x			x	x	x	x