CANADIAN GUIDELINES ON AUDITORY PROCESSING DISORDER IN CHILDREN AND ADULTS: ASSESSMENT AND INTERVENTION

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CISG The Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology

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CASLPA | ACOA Canadian Association of Speech-Language Pathologists and Audiologists

CAA Canadian Academy of Audiology Heard. Understood. ACA Académie canadienne d'audiologie Entendus. Compris.

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Interorganizational Steering Group for Speech Language Pathology and Audiology

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Update and review

It is recommended that the content of this document be reviewed and updated every three years, or as required based on substantial changes in research and practice in the area of assessment and management of auditory processing disorders.

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Executive Summary

The Canadian Guidelines for Assessment and Management of Auditory Processing Disorder in Children and Adults project was initiated by the Canadian Interorganizational Steering Group for Audiology and Speech-Language Pathology, and created the first national guidelines developed for Canada. The document aims to introduce a theoretical ecological framework that considers the Canadian context, and takes into account changes in audiology practice environments, the most recent international recommendations regarding auditory processing disorder, changes in general approaches to health and advances in relevant sciences (such as cognitive hearing science and cognitive neuroscience). It is based on the foundation laid by the World Health Organization International Classification of Functioning, Disability and Health, or ICF (WHO, 2002). The ICF has functional health as its primary focus, and emphasizes the importance of the interaction between an individual's health conditions or status, and the contextual factors around him/her. This report is based on a perspective that shifts the focus from cause to impact, from biological dysfunction to an individual's ability to participate fully in his/her own life and in society; it emphasizes the importance of thinking about auditory processing as a part of the construct of cognitive hearing science, which considers the interaction between hearing and cognition. The British Society of Audiology's (2011a) categorizations of developmental auditory processing disorder and acquired/secondary auditory processing disorder were used to address the impact of this disorder on children vs. adults. The document proposes a management model based on the ICF which describes and addresses both personal and environmental (physical, social and societal) factors. Recommendations are provided in three areas – conceptualizing and researching the construct of auditory processing disorder, training clinicians and facilitating continued learning, and providing, enhancing and coordinating effective services for clients. Recommendations related to conceptualization and research of auditory processing disorder focus on the need to research the psychometric properties of commonly used clinical tests, and to develop and research clinical tests in French, the other official language of Canada. Continuing to work towards a cohesive definition of auditory processing disorder within an ecological framework was also identified as an important need. Recommendations regarding training clinicians and facilitating continued learning focus on the importance of providing a broad-based, interdisciplinary education for audiologists and speech-language pathologists in this area, providing mentorship opportunities for clinical practice, and finding innovative ways for professionals to continue learning from the research and from professional collaboration. Recommendations related to providing, enhancing and coordinating effective services call for audiologists and speech-language pathologists to advocate for effective, integrated services for clients (such as advocating for a stronger audiology presence in schools, and long term care facilities), and for improved inter-professional teamwork and services.

CHAPTER 1

INTRODUCTION AND FRAMEWORK

1.1. Introduction

Auditory processing as an area of research and practice has its roots in the mid 20th century, and much has been written about assessment of the central auditory system in the past 60 years. Bocca, Calearo and Cassinari (1954) experimented with ways to stress the auditory system to help identify lesions of the central auditory system, finding that by using filtered speech on individuals with temporal lobe tumours, that the ear contralateral to the lesion had poorer word recognition scores. Around the same time, Myklebust (1954) described the importance of testing the central processing abilities of individuals with communication disorders. In 1961, Doreen Kimura proposed a theory that would attempt to explain dichotic listening abilities in humans. As a testament to her theory, her views on dichotic processing of auditory information recently celebrated a 50th anniversary. Since the 1970s, auditory processing has steadily received attention both clinically and as a research entity.

Many of the tests still used clinically today by audiologists were developed in the 1960s and 1970s (Emanuel, Ficca & Korczak, 2011); these include tests such as the Staggered Spondaic Word Test (Katz, 1962) and the low pass filtered speech test (Willeford, 1977). The primary clinical use for these tests initially was to pinpoint specific sites of lesions based on observed difficulties with specific auditory skills. This perspective assumed that it is possible (and clinically useful) to identify boundaries between "peripheral" and "central" auditory systems. However, the fields of neuroscience, neuroanatomy, neuroimaging and related disciplines have provided a much better understanding of the auditory system. While there have been immense leaps in our understanding of how the brain works, in the technology available to help clients, and in the ways in which audiologists practice today, the audiological test battery approach continues to focus on identifying disconnected areas of difficulty, when current evidence instead suggests that the brain is characterized by highly complex interactive networks, recently dubbed the "human connectome" (Sporns, 2011).

In audiology, there has been a reliance on an anatomical framework, and a perspective that viewed an array of auditory functions as modular processes that could be delineated from each other, and assessed independently from each other. Despite everything that has been learned about the neuroanatomical bases of auditory processing, this perspective has achieved limited success in guiding clinical practice, particularly given the reality that many, if not most, of the clients seen by audiologists do not have localizable disorders (or at least, not localizable using today's procedures and technologies). Furthermore, beyond the shift in the diagnostic landscape, new vistas to treatment have opened with new findings demonstrating the plasticity of the brain throughout the lifespan. There are new expectations that practice will be based on evidence and this evidence requires us to formulate new kinds of outcome measures that have validity not at the level of anatomy but at the level of ability of the person to function in their everyday life.

1.2. Moving to a 21st century perspective

Historically, the role of the test battery was the identification of site of lesion for auditory system abnormalities. While diagnostic techniques such as magnetic resonance imaging (MRI) have largely replaced this function, use of the auditory processing test battery continues to be a valuable and important part of audiology practice and can serve many important functions. Assessment results can provide guidance in designing and evaluating direct intervention therapies and the use of assistive technologies, in differentiating auditory maturation from more permanent auditory disorder in children, and in defining auditory neuroplasticity or deterioration. Audiologists may even play a role in prevention of auditory processing disorder. For example, animal research and emerging human research suggests a potential link between the effects of cumulative noise exposure and auditory processing difficulties, without change in audiometric thresholds (Chang & Merzenich, 2003; Groschel, Müller, Götze, Ernst, & Basta, 2011; Kujawa & Liberman, 2009; Shtyrov et al., 2000). If cumulative noise exposure has the potential to aggravate neural degeneration without changes in hearing detection, tests of auditory processing could be valuable in prevention of later problems.

Researchers have speculated for many years on the effects of otitis media on auditory processing difficulties in children (see Whitton & Polley, 2011 for a comprehensive review). The test battery may help to identify children at risk of auditory processing difficulties, perhaps related to earlier chronic otitis media or other risk factors, and prevent secondary learning and social problems. Moreover, tests of auditory processing might have the potential to obtain a better portrait of the capacities/incapacities of individuals using hearing aids or a cochlear implant. Integration of the construct of auditory processing into, for example, hearing aid prescription and fitting for adults, is increasingly indicated (Arlinger, Lunner, Lyxell, & Pichora-Fuller, 2009; Pichora-Fuller & Singh, 2006).

Arlinger et al. (2009) describe the need for a new field of study, cognitive hearing science or auditory cognitive science, to provide a framework in which to consider the interactions between hearing and cognition. They suggest that difficulties, and coping mechanisms, in listening, language processing and communicating in the complex listening environments encountered by infants, children, adults and seniors every day can only be understood and managed within an interdisciplinary framework which interfaces hearing and cognitive research. Depending on the case, it may be appropriate for an audiologist, a neuropsychologist/psychologist, a speech-language pathologist or another professional to take the lead role as case manager; however, client needs cannot be appropriately met unless professionals have an understanding of the knowledge and perspectives that each brings to the table.

The auditory processing test battery should be considered a tool to define auditory capacities and incapacities of individuals evidencing difficulty with listening and communication, and guide intervention through a comprehensive and ecologically based service delivery model, rather than only as a tool to delineate site of lesion along the auditory system.

1.3. Working within a theoretical framework for the Canadian context

These guidelines aim to introduce a theoretical ecological framework that considers the Canadian context, and takes into account changing audiology practice environments. They are based on the foundation laid by the World Health Organization International Classification of Functioning, Disability and Health (WHO, 2001), hereafter referred to as the ICF. The ICF has functional health as its primary focus, and emphasizes the importance of the interaction between an individual's health conditions or status, and the contextual factors around him/her. These guidelines also weave in the construct of acoustic ecology, the relationship between human beings and their environment, mediated by sound (Westerkamp, 2001). In our case, the relationships of interest between the person and the environment are mediated by sound processed by the auditory system. The relevance of this concept to audiologists is reflected in the concepts "acoustic ecology" and "auditory ecology" in audiological rehabilitation.

Difficulties with auditory processing come to the forefront in complex listening environments and are not always well predicted in the decontextualized assessments that occur in sound rooms.

Considering the interaction between the individual and his/her physical and social environment is crucial. The interface between auditory processing, cognitive processing and processing in other sensory modalities for each individual is also crucial (for example, between auditory processing and attention in children, between auditory processing and dementia, or between auditory and visual processing in older adults).

The ICF framework was applied to the study of auditory processing disorder in a review of audiology practice in Quebec, by the Ordre des orthophonistes et des audiologistes du Québec (2007); these guidelines acknowledge and build on that work. The ICF allows us to consider auditory processing within a framework that considers both the clinical manifestations of a presumed underlying auditory system abnormality, and the ways in which these difficulties are exacerbated or ameliorated by environmental and personal factors. It provides a framework within which to consider the assessment findings, and to choose appropriate recommendations. Therefore, while this document is referred to as a "guideline," its intent is not to provide a prescriptive or directive approach, but rather to summarize current evidence-based research (where it exists), to address considerations for decision making, and to suggest an approach to management which emphasizes the functional impact of the disorder.

1.4. Guideline consumers

Practice guidelines are typically developed primarily for use in clinical practice, based on a perceived need by clinicians. Near the beginning of the guideline development process, a survey for audiologists and speech-language pathologists was created by the committee and presented online. Through questions regarding practice in this area, responses indicated a number of areas in which clinicians expressed uncertainty or a lack of confidence in the levels of evidence available in the research, and in the guidance for management provided in the literature. Only 45% of clinical audiologists reported offering auditory processing assessment; 55% of audiologists reported that they do not offer this service at all, reflecting in some part the changing nature of practice environments (approximately half of respondents worked in private practice, and the other half in health care or rehabilitation/long-term care facilities). Many audiologists indicated that their practices were busy with other areas or that auditory processing was not an area of interest for them. However, among audiologists who did not offer auditory processing services, 37% reported not feeling comfortable with their knowledge base in the area of auditory processing. Other reasons for not offering services included "I don't feel comfortable providing recommendations or intervention" (25%), "there are no follow-up services in my community following the assessment" (23%), "I don't feel comfortable with the sensitivity/specificity of the tests" (20%) and "I don't feel comfortable with the evidence regarding assessment and intervention" (20%). These results suggest challenges in practice in this area. Clinicians working with children spoke of a significant disconnect between clinic and school, and of a lack of interdisciplinary coordination that made development and implementation of a cohesive program plan virtually impossible. Clinicians working with adults reported a lack of demand for auditory processing assessment in this population, despite what is known in the research literature about the aging population and deterioration in auditory processing skills. It may also be the case that cost for tests and availability of the equipment necessary to do comprehensive evaluations (such as evoked potentials) is an issue.

In response to the question "how much do you feel practice has advanced in this area over the years?", 41% responded "somewhat" and 29% responded "very little." These results echo those of Chermak, Traynham, Seikel and Musiek (1998), who surveyed audiologists in the United States about their graduate training in the area of auditory processing. Results indicated that 78% of audiologists were less than satisfied with their education in this area, and few had more than five hours of clinical training in this area. In follow up to the annual Burton Conference of 2000 on auditory processing disorder, Emanuel (2002) surveyed American audiologists and found that none of 192 responding audiologists followed the recommended minimum test battery developed at that conference. Chermak, Silva, Nye, Hasbrouck and Musiek (2007) indicated that improvements have been made on a number of fronts but issues still exist in the area of assessment and management of auditory processing disorder. Canadian data has indicated a similar trend from surveyed audiologists (Noel, Atkinson, Comeau & Ryan, 20002).

A clear frustration with practice in this area was evident from both audiologists and speech-language pathologists. Challenges in producing practice guidelines in the face of a lack of even consensus as to the definition of auditory processing disorder, limited (and sometimes conflicting) empirical guidance regarding which tests to administer and how to interpret the results, and the difficulties in recommending interventions which often have no more than anecdotal evidence, are considerable. The recent guidelines of the British Society of Audiology (2011b), note “researchers are demanding empirical evidence before endorsing diagnostic criteria and intervention strategies whilst clinicians, seeing individuals with ‘suspected APD’, are demanding guidelines for best practice at this time” (p. 5). These guidelines attempt to integrate both the research literature in this area and the realities of clinical practice into the ecological framework of the ICF.

While audiology practice guidelines tend to be traditionally directed towards audiologists, there are other consumers of guidelines for the assessment and management of auditory processing disorder in children and adults. These include other education and health care professionals who work with this population of individuals (speech-language pathologists, educators, physicians, long-term care facility staff, nurses, psychologists, etc.). Faculty of audiology and speech-language pathology training programs are responsible for offering programs which reflect the best evidence-based research practice, and which develop a sound theoretical knowledge base and competent clinical skills through practicum placements. The field of auditory processing disorder represents an intersect between many fields, such as health care, education, rehabilitation and long-term care, and community services, and therefore other health care professionals are potential guideline consumers. Foli and Elsisy (2010), and Neville, Foli and Gertner (2011), for example, describe the roles that nurses can play for children with auditory processing disorder and their families in terms of looking for red flags during well-child checks, communicating with parents and children, providing information to health care teams and gathering information to guide appropriate referrals.

This document is intended to address both pediatric and adult populations; however, it is assumed that some readers will find Chapter 3 (children) or Chapter 4 (adults) more relevant and will read selected sections. For this reason, some information and figures are duplicated or are very similar between chapters, where the information is relevant to both populations.

CHAPTER 2
GUIDING PRINCIPLES, DEFINITIONS AND COMPETENCIES

2.1. The International Classification of Functioning, Disability and Health

The World Health Organization International Classification of Functioning, Disability and Health (ICF) describes three levels of functioning – functioning at the level of the body or body part, functioning at the level of the whole person, and functioning at the level of the whole person in a social context (WHO, 2002). Addressing an individual's difficulties then, requires consideration of potential impairment at the level of the body/body part, activity limitations for the individual, and restrictions in participation in a social context. In the ICF framework, functional health must be considered in terms of the interaction between an individual's health conditions or status and the contextual factors around him/her. Figure 1 depicts the primary components of the ICF model, each component of which is described by codes which can be used clinically to develop a picture of an individual's functional health (see WHO, 2001 for an overview of the ICF checklist for clinical use).

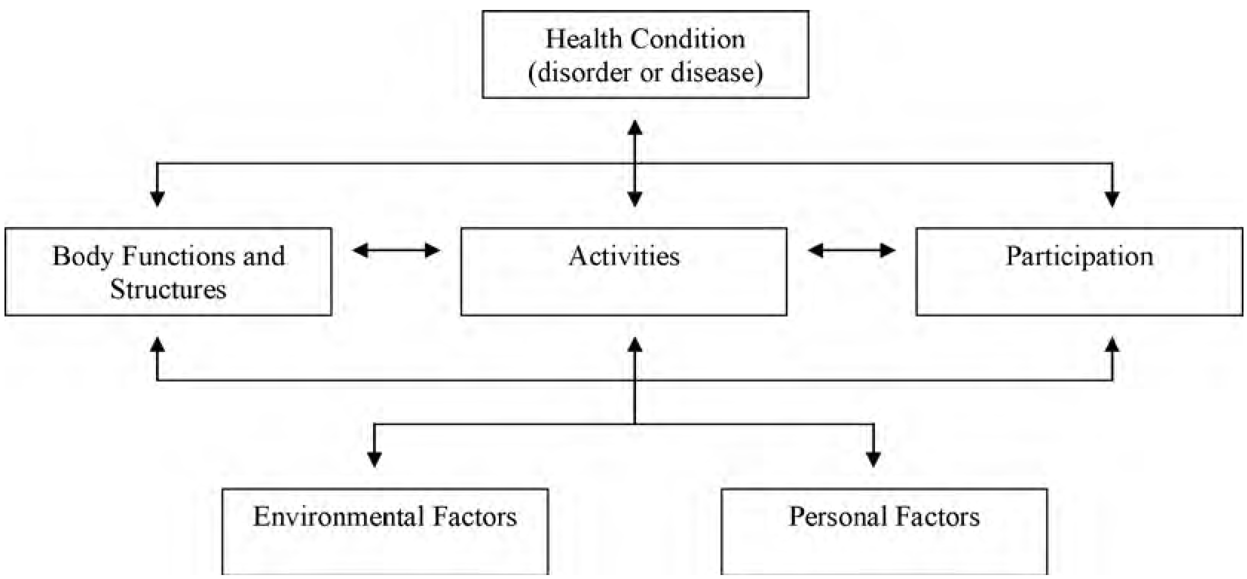

Figure 1. From the International classification of functioning, disability and health (ICF) (p. 18), by the World Health Organization (WHO), 2001, Geneva, Switzerland: Author.

2.2. Body functions and structures

The body functions and structures domain of the ICF describes functioning at the anatomical and physiological levels. Body structures describe anatomical structures, while body functions are described as the physiological functions of body systems. Examples of body functions are hearing, muscle tone, seeing, attention, memory, perception, higher-level cognitive functions, and language.

Several of the auditory processing functions commonly assessed by clinical auditory processing tests are included in the ICF, such as auditory perception, (defined as mental functions involved in discriminating sounds, tones, pitches and other acoustic stimuli), hearing functions (defined as sensory functions relating to sensing the presence of sounds and discriminating the location, pitch, loudness and quality of sounds), listening (using the sense of hearing intentionally to experience auditory stimuli, such as listening to a radio, music or a lecture) and a variety of mental functions (such as sustaining and dividing attention, short- and long-term memory and higher-level cognitive functions).

2.3. *Activity and participation*
The activity and participation domain refer to an individual's ability to carry out tasks and actions (activities) and his/her ability to participate in all aspects of his/her life, such as school, work, home and community (participation). The ICF includes categories such as learning and applying knowledge, general tasks and demands, communication, mobility, self-care, domestic life, and interpersonal interactions and relationships. While some categories of activity and participation in the ICF may not be applicable to a study of auditory processing disorder (e.g., mobility and self-care), others (such as communication and learning/applying knowledge) are clearly relevant to our work with individuals and their families. However, assessment of the activity and participation domains can only be conducted within an ecological framework which considers the impact of disordered body functions on the individual's ability to perform the activities of his/her daily life, and his/her ability to participate fully at home, school, work and in the community.

2.4. *Contextual factors*
Contextual factors ''represent the complete background of an individual's life and living'' (WHO, 2001, p. 16), and are considered in terms of environmental factors and personal factors. Environmental factors refer to all aspects of the external world of an individual's life that may have an impact on his or her functioning. Personal factors refer to "internal" aspects of an individual, some of which may be fixed (such as age), and others that are more changeable (such as coping styles, lifestyle or education).

2.4.1. *Environmental factors*
Environmental factors in the ICF include five domains which describe both the physical environment and the social environment of the individual – (1) products and technology; (2) natural environment and human-made changes to environment; (3) support and relationships; (4) attitudes; and (5) services, systems and policies. In the context of the population of individuals with auditory processing disorder, areas such as the provision of assistive listening devices, acoustical accommodations and modifications to the listening environment, support from family and school/work, the use of supportive communication strategies (such as rephrasing) and support services (such as development of an individual education plan for children or treatment plan for adults) might fall into the environmental factors category. The framework, then, allows us to consider and evaluate environmental factors as facilitative, or negative.

2.4.2. *Personal factors*
Personal factors include gender, age, educational level, coping styles, learning styles and other factors specific to each individual. In considering the impact of auditory processing disorder on an individual's daily communication functioning, it is clear that this reflects a nonlinear relationship between body functions and structures, activity and participation (the individual's ability to execute tasks such as following a complex oral direction or participating in a group discussion) and mediating contextual factors (such as the nature of the acoustical environment, the support of an assistive listening device or the individual's self-concept and self-confidence). Difficulty in specific aspects of auditory system functions and structures may result in difficulties and restrictions in activity and participation in the classroom, for example. However, it is also possible that supportive contextual factors (such as parental support, effective metacognitive strategies and an excellent teaching and learning environment) may neutralize potential negative impacts of auditory function and structures deficits.

Several researchers have adapted and distilled the large number of ICF codes into a set of core codes applicable to language impairment (Dempsey & Skakaris-Doyle, 2010; McLeod & Threats, 2008; Simeonsson, 2003; Westby, 2007). Dempsey and Skakaris-Doyle (2010) suggest that "the

ICF's conceptual framework permits a broader, more integrated view of the functioning of children with language impairment than does the traditional perspective on etiology by providing an account of how children's core linguistic processes, their ability to use them in social interactions, and the environmental and personal factors at play may interact." (p. 425). Guidelines and work based on the ICF are increasingly seen both in the field of communication disorders, and in fields such as psychology, dentistry, physical therapy and nursing (American Psychological Association, 2003; American Speech and Hearing Association, 2001, 2004a, 2004b; Brown & Hasselkus, 2008; Glässel, Kirchberger, Kollerits, Amann & Cieza 2011; Howe, 2008; Kim & Coenen, 2011; O'Halloran & Larkins, 2008; Petrovic, Markovic & Perry, 2011; Smiley, Threats, Mowry, & Peterson, 2005). The present guidelines do not undertake the task of applying or adapting the extensive coding and classification system outlined by the ICF to auditory processing disorder; rather, they suggest that fitting the audiologist's work with individuals and their families into the conceptual framework of the ICF allows us to produce a more cohesive, holistic approach than considering auditory processes in isolation. As Dempsey and Skakaris-Doyle (2010) point out, our ultimate goal is to improve the daily communication functioning of individuals.

The World Health Organization (2002) suggests that the ICF will be applicable to practice at a number of different levels. These include the following:

- Assessment at the individual level (for assessment, treatment planning, evaluation of treatment, communication among professionals and self-assessment by individuals)
- At the institutional level (for education and training purposes, for resource planning and development, for quality improvement, for management and outcome evaluation, and for considering models of service delivery)
- At the societal level (for eligibility criteria to ensure fairness and equity, for social policy development, for population needs assessments and for environmental assessment for universal design, identification of barriers and making changes to social policy)

The ICF model provides a valuable theoretical framework for considering the impact of auditory processing difficulties on individuals and their families. Ecological systems models, as described by Bronfenbrenner (1989, 1994), suggest that factors related to the larger community (workplaces, schools, nursing homes, community spaces, etc.) need to be considered as well. The inclusion of audiologists in school teams, in architectural design for new buildings, in home care, on stroke teams, and in other non-traditional contexts will help to ensure that potential difficulties in hearing and understanding are highlighted in these settings. Audiologists may then also have the opportunity to impact policy and practice to encourage universal design for hearing and communication in a wide variety of community settings.

These guidelines are intended to reflect the spirit of the ICF framework through the following two primary principles:

1. The primary focus of assessment and intervention must always be on meeting the needs of the individual and his/her family, based on an evaluation of how auditory processing difficulties impact performance and participation.

2. Assessment and intervention must always occur in the context of an ecological model, considering clinical, educational, social, vocational and community needs.

2.5. Professionals involved in assessment and management of auditory processing disorder

As professionals with training in the anatomy and physiology of the auditory system, and in the functional implications of various auditory disorders, audiologists have a particular perspective on assessment of auditory processing disorder. Assessment of discrete auditory capacities requires acoustic control of test stimuli and test environment through testing in a sound proofed booth, and is therefore most appropriately conducted by audiologists. While it is important that the biological bases of auditory processing disorders be understood as fully as possible, the task of the audiologist does not end there and we must use this knowledge of auditory biology as part of the larger model, especially as the model of health delivery shifts more from hospital to community settings.

Historically, when testing focused on the identification of neurological problems such as acoustic neuromas in adults, assessment and management of auditory processing disorder occurred within the medical system (e.g., hospitals). Today, however, the focus of auditory processing assessment and management has shifted to children with more developmental forms of auditory processing disorder, and to adults who have processing difficulties resulting from, or related to, age-associated declines in cognitive processing, presbycusis, noise exposure, or neurological events such as concussion, stroke or dementia, and therefore many professionals may be involved with clients and their families. Models of service delivery have changed over the years, and have broadened to include the practice of audiology in schools, in industry, in long-term care facilities, in rehabilitation centres, in private practice and in a variety of other settings. Models of service delivery differ widely across Canada, as reflected in the clinician survey; however, it is the case that while the impact of auditory processing disorder is reflected in school, in social situations, in the workplace and in the community, the primary burden of identification and treatment is often on health care. Audiology services within the health care sector (e.g., hospitals) and the private sector are not always well integrated with educational, community and vocational services. However, as described in Section 1.4, Guideline consumers, the importance of audiologists working with other professionals such as speech-language pathologists, educators, psychologists, physicians, long-term care staff and others, cannot be overemphasized. The nature and functional impact of auditory processing disorder requires the integration and coordination of a variety of perspectives, knowledge, and skills.

2.6. Definition of auditory processing disorder

With reference to the ICF, auditory processing disorder is presumed to originate in the auditory system (body functions and structures) and is characterized by a persistent limitation in the performance of auditory activities and significant consequences on participation. In the ICF model, *capacity* is defined as executing tasks in the standardized environment (e.g., in an audiological sound room); *performance* is defined as executing tasks in the everyday environment (in the individual's daily life). These auditory activity limitations may be evident in assessing capacities (e.g., speech discrimination in noise, temporal resolution via gap detection, pitch perception, binaural processing as in masking level differences). Importantly, they also affect performance, such as conversing at a cocktail party, localizing a siren on the street, understanding a multistep instruction in the classroom or appreciating music. Such problems will undermine participation of learners in educational settings, of workers in occupational settings and of individuals in a wide range of community roles. For practical purposes, functional problems which are explained adequately in terms of loss of auditory acuity (e.g., speech perception problems explainable in terms of loss of audibility given audiometric threshold elevations) are not dealt with in this discussion. Furthermore problems that are adequately explained by non-auditory deficits (e.g., language comprehension problems explainable in terms of delays or disorders in language development, attention, memory or cognition) are also excluded. However, the current report will include auditory communication problems for which it is clinically relevant to consider auditory processing problems that may involve multiple levels of the auditory system or multiple deficits. Note that our inclusion criteria are defined in terms of functional problems rather than in terms of site of lesion being central versus peripheral.

The British Society of Audiology (2011a) defines the following three categories of auditory processing disorder which are referenced in these guidelines:

1. Developmental auditory processing disorder: Cases presenting in childhood with normal hearing acuity (i.e., normal audiometry) and no other known etiology or potential risk factors. Developmental auditory processing disorder may continue into adulthood for some individuals, while other individuals can demonstrate improvement in test scores to within the average range over time.

2. Acquired auditory processing disorder: Cases associated with a known event (e.g., acquired brain injury, stroke, tumours, infection and age-related neurological deterioration) that could plausibly explain the auditory processing disorder.

3. Secondary auditory processing disorder: Cases where auditory processing disorder occurs in the presence, or as a result, of peripheral hearing impairment. This includes transient hearing impairment related to otitis media, or progressive hearing loss related to presbycusis.

For these guidelines, the categories of acquired APD and secondary APD have been considered together in Chapter 4, which addresses the needs of adults of all ages.

2.7. Prevalence of auditory processing disorder

Prevalence rates of auditory processing disorder in both children and adults have been difficult to confirm, and reports in the literature are inconsistent. Intuitively, prevalence rates should differ across age of the population; overall, the research suggests that auditory processing disorder is relatively infrequent in children and young adults, but quite common in adults with brain injuries (for example, with traumatic brain injury in veterans), and very common in seniors.

In children, it is estimated to affect between 2 and 3% (Chermak & Musiek, 1997). Recent research suggests that difficulties with auditory processing disorders in adults with neurological events such as stroke, traumatic brain injury and military-related trauma, and in seniors with presbycusis and aging auditory systems, may be more prevalent than previously thought (Dobreva, O'Neill, & Paige, 2011; Fausti, Wilmington, Gallun, Myers & Henry, 2009; Frisina & Frisina, 1997; Grose, & Mamo, 2010; Idrizbegovic, Hederstierna, Dahlquist, Kämpfe Nordström, Jelic, & Rosenhall, 2011; Janse, 2009; Kumar, 2011; Talvitie, Matilainen, Pekkonen, Alku, May, & Tiitinen, 2010). For example, more than 50% of adult and pediatric clients with traumatic brain injury experience auditory processing difficulties (Bergemalm & Lyxell, 2005; Flood, Dumas, & Haley, 2005). In the United States, the number of individuals with possible traumatic brain injury induced auditory processing disorder has increased as significant numbers of veterans (10–20%) with head injuries have returned home from Iraq and Afghanistan (Martin, Lu, Helmick, French & Warden, 2008; Okie, 2005). While data is not available, there is no reason to suspect that the same trend is not mirrored in Canada.

Auditory processing difficulties in aging adults is an area of emerging importance to which more attention has shifted increasingly over the past two decades since the publication of the seminal CHABA report (*Committee on Hearing, Bioacoustics, and Biomechanics, 1988*). Advances in our knowledge of auditory aging are comprehensively summarized in a recent edition of the *Springer*

Handbook of Auditory Research (Gordon-Salant, Frisina, Popper & Fay, 2009). With aging, difficulty with discrimination in noise is an extremely common complaint, often beginning before pure tone threshold elevations are seen. The prevalence of presbycusis is such that clinicians cannot consider the needs of the majority of their adult clients without considering some elements of more "central" processing problems. This is complicated by the fact that age-related difficulties in auditory detection and processing are often accompanied by deterioration in vision, memory and cognition, exacerbating the effects of auditory problems. Consideration of processing problems in older adults is critical in view of the research literature which suggests that auditory processing difficulties may be an early warning sign of cognitive decline and dementia (Gates, 2009; Gates, Beiser, Rees, D'Agostino & Wolf, 2002; Idrizbegovic et al. 2011; Lin, 2011; Lin, Ferrucci, Metter, An, Zonderman, & Resnick, 2011; Lin, Metter, O'Brien, Resnick, Zonderman, & Ferrucci, 2011; Lin et al., 2004).

2.8. Clinical competencies

2.8.1. Clinical knowledge base

Several clinician surveys (including the survey conducted for the development of these guidelines) have indicated that many audiologists are not practicing in the area of auditory processing disorder (Chermak, Silva, Nye, Hasbrouck, & Musiek, 2007; Chermak, Traynham, Seikel, & Musiek, 1998). In the online survey, only 45% of audiologists reported offering auditory processing assessment for children, with a variety of reasons offered ranging from lack of time, to lack of confidence in the tests, to lack of available intervention services following assessment. An informal survey of Canadian graduate programs in audiology done for the development of these guidelines suggests that students are graduating with a good theoretical foundation in this area, and that there is a significant amount of information about auditory processing (including electrophysiological assessment) embedded throughout courses in pediatrics, rehabilitation, hearing science, etc. However, practicum experience appears to be more limited (a finding also reported in the Chermak et al. surveys), which may account for some audiologists feeling uncomfortable with practicing in this area. Of note is the fact that almost 40% of audiologists serving adults, and 53% of audiologists serving children noted that the lack of availability of professional development opportunities was an area of frustration for them.

Assessment and management of auditory processing disorder in children and adults should be considered part of a standard set of core competencies for all audiologists. However, audiologists need to be supported through the provision of continuing learning opportunities by professional organizations and university training programs. Geographical, financial and time constraints can be significant barriers to access to such opportunities, but might be at least partially addressed by creative uses of web-based learning, including webcasts, virtual conferences, listservs and e-learning courses. Clinicians already established in APD practices can offer mentorship opportunities as an invaluable way to give back to their profession, and help transfer clinical skills to their colleagues.

In addition to understanding auditory processing disorder in children with developmental forms of APD, and adults with documented neurological lesions, audiologists must also begin to consider APD in the aging population. An emerging area of active research points to the importance of the interactions between auditory and cognitive processing during communication by "healthy" older adults with hearing loss who might be seeking rehabilitation, including hearing aids. A seminal Canadian study found cognitive impairments in almost 1 in 6 adults aged 75 to 84 years, almost 1 in 4 of those age, 85 to 89 years, over 1 in 3 of those aged 90 to 94 years, and over half of those aged 95+ years (Ebly, Parhad, Hogan, & Fung, 1994). Tragically, the degree of dementia has been reported to be significantly overestimated in about 1/3 of cases if tests are conducted without versus with hearing aids (Weinstein & Amsel, 1987). Even more striking are the findings from epidemiological studies that audiometric thresholds (Lin et al., 2011) and performance on some tests of central auditory or speech processing (Gates et al., 2002) are predictive of future manifestation of dementia. Moreover, dual sensory (hearing and vision) loss, which affects about 1/5 people over 80 years of age (Smith, Bennett, & Wilson, 2008), is associated with even greater odds for cognitive decline and for functional decline on everyday activities over a 4-year period (Lin et al., 2004). There is now a pressing need to position hearing health care as an important component in the larger context of healthy aging because recent research has underscored the possibility that those with hearing loss are at greater risk for developing future dementia compared to those who have good hearing and a need has been identified for future research to determine if interventions for hearing loss could contribute to the prevention or slowing of cognitive decline (Gates et al., 2011; Lin, 2011; Lin et al., 2011).

2.8.2. Knowledge of community resources

Working with individuals with auditory processing disorder and their families always requires a team approach. It is crucial that clinicians develop a good understanding of the community resources available to clients.

For children, this would include understanding how students with auditory processing disorder are served in the school system, identifying key contact people in the child's educational setting, and collecting and integrating information from parents, school professionals and others in clinical decision making. In the online survey, an apparent disconnect was noticed between speech-language pathologists and audiologist respondents, with only 19% of audiologists reporting being concerned about a lack of follow-up by school staff regarding recommendations in the audiologist's written report. However, 64% of speech-language pathologists reported a lack of understanding by school staff of auditory processing disorder, and 50% reported difficulties with follow-up by school staff. This may suggest a lack of understanding by clinical audiologists of the policies, and day-to-day realities, of the delivery of services for children with auditory processing disorder in the school system.

Across Canada, available services in school systems range from the provision of direct intervention/therapy programs requiring a diagnosis of auditory processing disorder, to provision of speech-language pathology consultative services only, to fitting of an FM system only by a teacher of the deaf/hard of hearing, to no formal support service provision at all. It is imperative that information flows both ways; that school staff has a good understanding of auditory processing disorder, but also that clinical audiologists have a good understanding of the local educational content in their community, so that parents can be provided with accurate and comprehensive information regarding services available to their child.

For audiologists serving adult clients, knowledge of community resources could include familiarity with consumer support groups, programs for seniors, follow-up services for individuals with traumatic brain injury or other neurological insults, or supports for families and caregivers. Audiologists should strive to seek and develop professional relationships with members of their local health care teams. There is a great need for the work of audiologists to become more prominent in geriatric care, and for their role to be expanded beyond simply the prescription and fitting of amplification. One of the interesting findings of the clinician survey was the very small number of audiologists who indicated that they work with adults in geriatric care, long-term care or rehabilitation settings, suggesting a significant gap in services for these clients.

CHAPTER 3
ASSESSMENT AND MANAGEMENT OF CHILDREN WITH AUDITORY PROCESSING DISORDER

The ICF model has as its primary focus, an emphasis on functional health and on the interaction between an individual's health conditions or status and the contextual factors around him/her. Consideration and assessment of disorders of body structures and functions is only one step in the process of understanding the ways in which the difficulties arising from these disorders are exacerbated or ameliorated by environmental and personal factors.

This chapter is based on the premise that most cases of auditory processing disorder in children are developmental in nature. While clinicians do see children with identified neurological difficulties such as stroke, brain tumours, and side effects from chemotherapy, etc., these do not reflect the bulk of a pediatric caseload. Research is beginning to examine more closely the link between chronic otitis media and subsequent auditory processing difficulties, and the presence of a cluster of neurological sequelae described by Whitton & Polley (2011) as "amblyaudia" (Moore, 2007; Whitton & Polley, 2011; Zumach, Gerrits, Chenault, & Anteunis, 2009). Conductive hearing loss associated with chronic otitis media, when occurring during critical periods of neurological development, is theorized to result in degraded afferent signal quality through reduced amplitude of auditory signals, delayed transmission of auditory signals introduced by thick fluid, and interaural time and intensity differences introduced by asymmetrical hearing loss during critical periods of neurological development (see Roberts, Rosenfeld, & Zeisel, 2004, and Whitton & Polley, 2011 for comprehensive reviews of the literature in this area). Some research has also demonstrated a higher incidence of auditory processing difficulties in children born prematurely (Gallo, Dias, Pereira, Azevedo, & Sousa, 2011; Gozzo et al., 2009; Mikkola et al., 2007). In general, however, this chapter examines the assessment and management of children with auditory processing difficulties for whom a clear cause cannot be identified.

3.1. Indications for referral

Referrals for an auditory processing assessment should be based on the impact of auditory processing difficulties on performance and participation at school, home and in the community. However, these symptoms are commonly shared with other disorders, and research indicates both that many children with auditory processing disorder show evidence of language and learning difficulties, and many children diagnosed with language and learning difficulties show evidence of difficulty with many auditory processing tasks. Chermak et al. (1998) showed that reports of being distracted and inattentive are symptoms common to children with auditory processing disorder and to those with attention deficit disorder with hyperactivity. Moore, Ferguson, Edmondson-Jones and Ratib (2010) found that listening difficulties often occurred with reduced visual alertness. Other researchers have found similar overlap between disorders (Jutras et al., 2007; Riccio, Cohen, Hynd, & Keith. 1996; Riccio, Hynd, Cohen, Hall, & Molt, 1994). These studies showed that between 40 and 60% of children diagnosed with auditory processing disorder also showed indications of attention deficits. Cook et al. (1993) reported that all of their subjects with attention deficit disorders failed at least two auditory tests. Sharma, Purdy and Kelly (2009) showed that almost half of children referred for suspicion of auditory processing disorder failed auditory, reading and language test batteries.

However, although there is a comorbidity with other disorders, auditory processing disorder is a hearing disorder. Children with auditory processing disorder will experience similar symptoms as those having a hearing loss. Chermak et al. (1998) noted that behaviours which are most indicative of auditory processing difficulties (as opposed to other comorbid conditions such as attention deficit hyperactivity disorder) include (in order of most often reported), difficulty hearing in background noise, difficulty following instructions, poor listening skills, academic difficulties, poor auditory association skills, distractibility and inattention. Whitelaw (2004) outlines how careful attention to reported behaviours and clinical test results can help to differentiate disorders with similar presenting symptoms, such as attention deficit hyperactivity disorder and autism spectrum disorder.

3.2. Personal factors

Personal factors as defined in the ICF model include factors that are specific to the individual, such as race, gender, age, educational level, coping styles, learning styles and other factors. Personal factors include those that are fixed (such as age) and those that are more fluid, developmental or changeable (such as coping styles or educational level). This section addresses the personal factors important to consider in the assessment of auditory processing.

3.2.1. Age

Research is clear that there is a long maturational timeframe for the development of auditory processing skills, a trajectory that continues well into adolescence (see Bellis, 2002 and Moore, 2002, for a comprehensive review). Research beginning in the 1970s and continuing until the present day has described the ability of infants and very young children to process complex auditory information (Trehub, 2005; Schneider & Trehub, 1985; Schneider, Trehub & Bull, 1979; Trehub & Rabinovitch, 1972; Trehub & Trainor, 1993); however, from a practical standpoint, there are limitations in assessing these auditory processing abilities in very young children in a clinical setting. Therefore, there must be a balance between identification of a problem as early as possible to prevent or reduce its impact on language and learning, and the potential for misdiagnosis of a problem because assessment practices are not reliable, valid or predictive of future problems.

These guidelines are consistent with others in the finding that behavioural tests of auditory processing abilities demonstrate reduced reliability and validity for children under the developmental age of 7 years (American Academy of Audiology, 2010; British Society of Audiology, 2011). Similarly, current evidence suggests that the use of electrophysiological measures for children yields highly variable results. Electrophysiological testing of younger children requires a thorough understanding of the maturational components of these waveforms, (Ponton, Eggermont, Kwong, & Don, 2000; Schochat & Musiek, 2006; Sussman, Steinschneider, Gumenyuk, Grushko, & Lawson, 2008). For those children with confirmed lesions of the central auditory system, evoked potentials can offer valuable information. Experience with assessment and waveform interpretation for this population is crucial.

3.2.2. Cognitive, developmental, personality and learning disorders

Behavioural assessment of auditory processing skills requires that children are able to understand the task requirements, have receptive and expressive language skills that enable them to understand, and respond to, speech stimuli, and have sufficient attention and memory to complete the tasks. If the presence of intellectual disability has been confirmed through psycho-educational assessment, auditory processing assessment should not be performed. For example, a child diagnosed with a mild intellectual disability (MID) on the basis of a psycho-educational assessment would very likely demonstrate scores below the normal range on a variety of tests of auditory processing. However, the difficulties with the cognitive, memory and language processing requirements involved in understanding the instructions and completing the tasks associated with MID are sufficient to explain poor test performance and do not imply a distinct auditory processing disorder. For many children, auditory processing assessment may be one of the first of a range of assessments in process and formal psycho-educational assessment results may not be available to the clinician. In these cases, where there are indications or concerns regarding cognitive delays, it is strongly recommended that good clinical judgment be employed, and clinicians defer auditory processing assessment until assessment by appropriate professionals (psychologists, neuro-developmental pediatricians, speech-language pathologists, etc.) has been completed.

Most behavioural tests of auditory processing require a spoken response from the child. Therefore, auditory processing assessment may not be appropriate for children whose multiple articulation errors or reduced speech intelligibility make interpretation of responses unreliable or invalid, unless a spoken response requirement can be modified to written or picture pointing responses.

The frequent presence of co-morbid learning difficulties such as learning disabilities, expressive and/or receptive language disorders, attention deficit hyperactivity disorder and others, has sparked debate in the research literature regarding potential cause/effect relationships and recommendations for assessing (or not). Discussion regarding the potential effect of other learning challenges on the results of auditory processing assessment has led to conflicting recommendations. The ICF framework focuses on the effects of a disorder on performance and participation (rather than on pinning down a disorder of a particular body structure). Therefore, evaluation of the degree to which a child with a language delay or disorder "breaks down" during difficult listening tasks provides valuable information with respect to performance in a classroom situation, whether or not a formal diagnosis of auditory processing disorder can be definitively made. For example, research indicates that children with specific language impairment (SLI) or with dyslexia had significantly lower performance on speech tests in noise (but not in quiet) than children without these disorders, a finding which has significant implications for the classroom even though the relationships between APD, learning disabilities and language impairment are not well understood (Ziegler, Pech-Georgel, George, Alario and Lorenzi, 2005; Ziegler, Pech-Georgel, George, & Lorenzi, 2009). While more research is needed, Mengler, Hogben, Michie and Bishop (2005) have shown that children with SLI have impaired frequency resolution abilities when compared to children in the control group. Such a finding would have far reaching implications on the child's abilities to learn to discriminate between sounds. Coordinated efforts between audiologists, speech-pathologists and educational psychologists are needed to ensure efficacious diagnosis and remediation.

Clinicians are also required to possess additional knowledge and skills, and to exhibit care and good clinical judgment when assessing children with other types of developmental or personality disorders (e.g., autism spectrum disorder, or personality disorders such depressive disorder). Dawes & Bishop (2009) discuss how the overlap in reported behaviours for different types of disorders creates challenges for clinicians. They noted "different conceptual and diagnostic approaches adopted by audiologists and psychologists can lead to a confusing picture whereby the child who is regarded as having a specific learning disability by one group of experts may be given an APD diagnosis by another." They further noted that "While this could be indicative of co-morbidity, there are concerns that different professional groups are using different labels for the same symptoms." Clinicians working with children need to be well-informed of the research literature describing potential auditory processing deficit underpinnings in children with other types of cognitive, developmental, personality and learning disorders.

3.2.3. Peripheral hearing loss

In this context, peripheral hearing loss refers to loss of audibility and an elevation in pure tone audiometric thresholds; any type of supra-threshold assessment necessarily involves some level of auditory processing. Some research has studied the influence of peripheral hearing loss on auditory abilities in children (Arnst, 1982; Jutras, 2006; Jutras & Gagné, 1999; Koravand, Jutras & Lassonde, 2012; Koravand, Jutras, & Roumy, 2010). However, as research does not yet provide clear guidance in this area, at this time, assessment of auditory processing should not be conducted for children with peripheral hearing loss of any degree or type. The problems related to inherent variability in the assessment of children, the often limited availability of adequate normative data, and the variability in auditory system maturation are considerable for children with typical hearing. Accounting for another variable in the form of peripheral hearing loss precludes the valid and reliable identification of auditory processing disorder for children with peripheral hearing loss. This does not suggest that auditory processing disorder cannot be present in children with peripheral hearing loss; both theory and clinical experience suggest that dysfunction can occur concurrently at many levels in the auditory system in an individual. It is expected that future research will provide a better understanding of the interactions between auditory dysfunctions arising from a variety of causes; however, at present, there is an insufficient level of evidence to guide valid and reliable assessment of children with peripheral hearing loss.

3.3. *Screening*

The use of behavioural checklists and questionnaires by speech-language pathologists, school professionals, parents/caregivers, and others can be a useful approach to determining whether a referral for auditory processing assessment is indicated. Providing a copy of such observational data to parents/caregivers to share with clinical audiologists provides valuable information to assist in test interpretation and the development of recommendations. However, it is important that if such checklists and questionnaires are used routinely for decision making for referrals by school teams, that school staff have an understanding of auditory processing, and understand the administration and interpretation of these screening instruments. Research has indicated weak or no ability of screening questionnaires to predict auditory processing disorder, including instruments such as the Children's Auditory Performance Scale (CHAPS) (Drake et al., 2006; Lam & Sanchez, 2007; Wilson et al., 2011), the Screening Instrument for Targeting Educational Risk (SIFTER) (Wilson et al., 2011) and the Test of Auditory Perceptual Skills-Revised (TAPS-R) (Wilson et al., 2011). Behavioural checklists and questionnaires should only be used to provide guidance for referrals, for information gathering (for example, prior to assessment or as outcome measures for interventions), and as measures to describe the functional impact of auditory processing disorder, <u>not</u> for the purpose of diagnosing auditory processing disorder.

A variety of behavioural screening tests of auditory processing disorder for clinical use by audiologists have also been developed. Such screening tests in isolation should be used only for screening <u>prior to further assessment</u>, and should not be used for the purpose of <u>diagnosing</u> auditory processing disorder.

3.4. *Assessment of auditory capacities*

Auditory capacities are defined as discrete auditory processes such as localization, lateralization, temporal resolution, etc. which are related to various structures and functions in the auditory system and brain (body structures and functions in the ICF model). In the early history of practice in the area of auditory processing disorder, there was a focus on pairing specific auditory capacities with specific auditory sites, such that a tumour at a specific location along the auditory pathway could be identified by reduced responses in a specific audiological test. The understanding of auditory processing has evolved considerably over the years, incorporating the roles of both afferent and efferent pathways, and the integration of other brain functions. However, there is still a role for delineating specific auditory capacities that are important for an individual's ability to function in everyday life.

Positioning the assessment of capacities within a broader ecological model, Anthony (1991) describes the construct of "decontextualized assessment." Decontextualized assessment refers to assessment that occurs outside of, and in isolation to, the individual's educational and social environment. The value of decontextualized assessment lies in its ability to isolate discrete skills and tasks, and to control for the effects of confounding variables. However, decontextualized assessment in a sound room may overestimate or underestimate a child's performance at home, in a classroom or in social or recreational contexts, where contextual factors may hinder or help the child's ability to function, and therefore results need to be considered in the context of the child's environment.

3.5. Pre-assessment information gathering and case history

It is extremely important that information from parents and school staff be obtained prior to testing. Contextual observation is an integral part of the evaluation of children with suspected auditory processing disorder, since listening can be highly influenced by environmental and personal factors such as classroom acoustics, attention and motivation, etc. It is recommended that parents receive a checklist or other observational tool to be completed by the child's teacher prior to the auditory processing assessment. Parents may also complete questionnaires. Moore et al. (2010) found a small but significant correlation between children's performance on auditory processing measures, and caregiver reports of communication and listening skills. Parents should also be encouraged to obtain, and bring with them, copies of assessments completed by other professionals (such as school psychologists, speech-language pathologists, special education resource teachers, etc.). For older children, self-assessment can be a valuable source of information both to obtain information on the child's perspective and experiences of listening and learning in the classroom and elsewhere, and to obtain a sense of the impact of listening difficulties on self-concept, self-esteem, motivation, affect, etc.

Information obtained from parents/caregivers during a case history should include, at least, pre-, peri- and post-natal information, physical developmental milestones, speech and language development, family history of learning and hearing difficulties, incidence of middle ear problems (intervention), allergies, academic skills (strengths and weaknesses), general health and information on his/her participation at school, at home, in sport and leisure as well as musical abilities.

3.6. Tools for assessment of auditory capacity

Standard audiometric assessment should always be the first step, including pure tone audiometry, immittance battery with both ipsilateral and contralateral acoustic reflexes, otoacoustic emissions, speech recognition and speech discrimination testing. The first step must be to establish whether or not the child has normal hearing sensitivity; most clinicians have encountered a case in which a child referred for assessment of auditory processing skills was found in fact to have mild hearing loss associated with serous otitis media or undiagnosed mild sensorineural hearing loss.

There is little research delineating an appropriate auditory processing test battery for children (or for adults, for that matter). Musiek, Chermak, Weihing, Zappulla and Nagle (2011) note that "use of multiple tests can potentially reduce diagnostic error by improving efficiency, increasing the face validity of the battery as a whole by incorporating a broader range of auditory processes, and providing guidance in establishing the most appropriate intervention goals and program planning." (p. 343). However, they also note that increasing the number of tests in a battery also increases the potential for false positives (i.e., identifying an individual as having an APD, when they do not), and increases cost. Therefore, when choosing the components for a test battery, we must ensure that the following two criteria are met:

1. The test battery must accurately identify the presence of APD. This requires audiologists to carefully research and evaluate the psychometric properties of individual tests, and to choose tests with good test sensitivity, specificity and efficiency, and with clear pass/fail criteria.
2. It must also assess and describe the individual's functional difficulties related to auditory dysfunction (requiring some individualization of the test battery to the complaints and functional difficulties reported).

With respect to accurate diagnosis of the presence of APD, test sensitivity, specificity and efficiency must be known. Sensitivity refers to the ability of a test to correctly identify individuals who do have a disorder, as having that disorder. Specificity refers to the ability of a test to "pass" individuals who do not have the disorder. Test efficiency is measured by the percentage of individuals classified correctly (true positives and true negatives). For children, the usual research methodology used for adults to establish a "gold standard", that of comparing performance of a group of individuals with confirmed auditory disorders (e.g., acoustic neuromas or brain tumours) against a control group of neurologically normal individuals, is not applicable. Musiek, Geurkink & Kietel (1982) used a different approach and assessed a group of children suspected of having APD based on previous interdisciplinary assessment and observation. They found that the Frequency Patterns Test, Competing Sentences Test, Dichotic Digits Test and Staggered Spondaic Word Test were most accurate in identifying APD, using a criterion of performance more than one standard deviation below the mean. Singer, Hurley & Preece (1998), using a similar methodology, found the Filtered Speech Test and Binaural Fusion Tests in combination to be the most cost effective and accurate battery (compared to a speech recognition MLD, Pitch Pattern Sequence Test, Staggered Spondaic Word Test, Dichotic Digits Test and time compressed speech).

Surprisingly little research using factor analysis has been used to address this problem. However, Schow and Chermak (1999) suggested factor analysis may be an approach to identify underlying bases of auditory processing difficulty, and found in a study of performance of 331 children suspected of having APD, that two clear factors emerged using the SCAN-C and SSW. These were a binaural "separation from competition" factor and a monaural low redundancy degradation factor (such as might be assessed by a filtered speech or speech-in-noise test). Dawes & Bishop (2007) also found these two factors to emerge in their factor analysis of the SCAN-C Test with British children.

Capacities to be assessed can include temporal sequencing/ordering, which can be assessed by tests such as Pitch Patterns Sequence Test (Musiek, Bromley, Roberts, & Lamb, 1990), and Duration Pattern Test (Musiek & Pinheiro, 1987); identification of speech in degraded listening situations (including listening in noise) which can be assessed by tests such as Synthetic Sentence Identification – Ipsilateral Competing Message (Jerger & Jerger, 1974), filtered speech, time compressed or reverberant speech (Keith, 2002); understanding low redundancy speech (such as low pass filtered speech or compressed speech with reverberation); binaural separation which can be assessed by tests such as competing words, or the Synthetic Sentence Identification – Contralateral Competing Message test (Jerger & Jerger, 1974); binaural integration which can be assessed by tests using dichotic stimuli presentation [e.g., digits (Musiek, 1983), words (Meyers, Roberts, Bayless, Volkert, & Evitts, 2002), and sentences (Musiek, 1983; Fifer, Jerger, Berlin, Tobey, & Campbell, 1983) or the Staggered Spondaic Word Test (Katz, 1962); binaural interaction which can be assessed by tests such as the Masking Level Difference Test; localization and lateralization which can be assessed by tests such as the Listening in Spatialized Noise Test (Cameron & Dillon, 2007; Cameron et al., 2009); temporal resolution, which can be assessed by tests such as the Gaps in Noise Test (Musiek et al., 2005), and the Random Gap Detection Test (Keith, 2000); auditory attention which can be assessed by tests as the Auditory Continuous Performance Test (Keith, 1994); and auditory memory which can be assessed by tests such as digit span or expanding memory tests.

Electrophysiology testing may be considered to complement behavioural assessment (e.g., auditory brainstem evoked response, middle latency response, late latency response, P300 and Mismatch Negativity). Cases where electrophysiological testing may be valuable include confirming an abnormal finding on behavioural measures, or obtaining information where limited behavioural assessment information can be obtained.

The time required to obtain a complete and clear picture of a child's capacities and incapacities will vary for each child, and therefore no recommendations are made regarding time limits. However, clinicians should always be sensitive to each child's ability to participate in assessment with respect of age, attention, motivation and other factors. Multiple sessions may be needed to obtain valid assessment results, depending on the child.

3.7. Interpretation of auditory capacity test assessment

Musiek et al. (2011) describe the challenges inherent in selecting a test battery that is representative and sensitive, but also time and cost effective. They note that "audiologists' primary responsibility must be to identify those with (C)APD with high accuracy (i.e., identify true positives) while minimizing the number of false positive and false negative diagnoses." In their study of the sensitivity and specificity of various tests to differentiate individuals with known auditory system lesions from individuals with normal auditory systems, they found that using a criterion of two failed tests for a positive diagnosis resulted in the best balance across efficiency (88%), sensitivity (90%) and specificity (86%), maintaining what would be considered clinically acceptable false positive and false negative rates.

Diagnosis of abnormal performance on tests of auditory processing must be based on performance below the cut-off scores or performance criteria provided by the test manual (commonly defined as performance deficits of at least two standard deviations below the mean), on at least two tests. ASHA (2005) recommends that where only results of only one test are used to diagnose auditory processing disorder, stricter criteria of performance deficits on one test of at least three standard deviations below the mean <u>and</u> reported significant functional difficulty in auditory behaviours reliant on the process are appropriate.

However, it must be acknowledged that these criteria represent only our best interpretation of an evolving research literature on the selection and use of clinical test batteries, and that we must continue to re-evaluate and revise our thinking as we learn more. Recently, a research team representing the National Acoustics Laboratories, Hearing Cooperative Research Centre and the University of Queensland in Australia (Dillon, Cameron, Glyde, Wilson & Tomlin, 2012) provided an excellent review and critique of current use of the test battery approach, and propose an alternative, hierarchical, adaptive mode. This model has as its first step the careful delineation of the functional problems that an individual has with listening in difficult conditions; once this has been described, a two step testing process including a master battery and a detailed battery is proposed. These authors challenge us to expand our conceptualization both of the disorder, and our approach to identifying it and providing effective management services to our clients.

It should be noted that, while the literature on test profiles is not definitive, when poor or inconsistent performance on <u>all</u> tests of auditory processing is seen, clinicians should be cognizant of the strong probability of disorders which are more global in nature, and less likely specific to the auditory channel (ASHA, 2005).

The British Society of Audiology (2011a) guidelines describe several frameworks that might guide interpretation of test results and management recommendations.

1. Functionally driven, that is, the individual's difficulties in everyday life and at school/work are matched with corresponding management strategies

2. Test driven, that is, management strategies are selected on the basis of test findings

3. Profile driven, that is, the individual is classified into an APD subtype, based on patterns in test results and proposed audiological or neurological underpinnings, and management is decided accordingly.

At present, test-driven and profile driven frameworks are not well supported by research. While theoretical models delineating profiles of auditory processing disorder have been developed, they are based in theoretical frameworks rather than being driven by clinical data, and there is limited evidence demonstrating their clinical utility. The two primary models in the literature are the Buffalo model (Katz, 1992) and the Bellis-Ferre model (Bellis, 2003). The Buffalo model relies primarily on test results from the Staggered Spondaic Word, classifying children who "fail" the test into one of four profiles: (1) Decoding, (2) Tolerance Fading Memory, (3) Integration and (4) Organization. Children with a decoding profile are those who experience difficulties in processing rapidly auditory information and in answering questions quickly. Tolerance fading memory refers to difficulties in understanding in adverse listening conditions and/or in remembering short-term auditory information (Katz, 1992). Children with an integration profile have problems in integrating auditory information with input coming from other modalities (Katz, 1992). Finally, children with temporal ordering problems are reflected in the organization profile (Katz, 1992).

In the Bellis-Ferre model, initially five profiles were included in the model, but this has been subsequently revised. Three primary profiles have now been described, along with two secondary profiles that are thought to reflect auditory difficulties without a primary auditory processing disorder. The three primary profiles are Decoding, Integration and Prosodic. These profiles are defined by integrating results of the auditory test battery. Decoding includes difficulties in listening in noise and poor analytic skills. Integration refers to difficulties in linking prosody and linguistic content, in spelling, in listening in noise, and in performing tasks requiring integration of interhemispheric information. Children with memory problems are also classified in this profile. The prosodic profile includes children who have difficulty perceiving and using prosody, decoding communicative intent, spelling, performing visuospatial tasks and with mathematics calculation.

Despite the use of common terms by the two models, the same term does not always refer to difficulties in the same auditory capacities. Jutras et al. (2007) used clinical data from children diagnosed with auditory processing disorder to categorize children according to the Buffalo and the Bellis-Ferre models. They found that more children were classified as fitting a specific profile in the Buffalo model than in the Bellis/Ferre model. The majority of children could not be classified at all into a specific profile. The Buffalo model relies on assessment of a single auditory capacity (binaural integration) and does not provide information on the other auditory capacities.

At present, it appears that models relative to auditory processing disorder are insufficiently developed and researched to be recommended for defining specific clinical categories of auditory processing disorder. In addition, links between theorized profiles and functional implications for everyday listening as well as recommendations for treatment and management have to be scientifically validated before their use in educational settings can be recommended.

3.7.1. Delay vs. disorder

Research on neurological maturation of auditory processing capacities clearly demonstrates the considerable variability between individuals, and the considerable time period over which complete maturation occurs. Although exact numbers are not known, Musiek (personal communication, 2011) has suggested that about 20–30% of children may show test results that improve to within the typical range over time. Prediction of which children may "grow out of" auditory processing difficulties, and which children will have persistent difficulties without significant improvement is not possible based on a single initial assessment. Therefore, when a first evaluation is completed and abnormal results are obtained, it is preferable to use the term "delay" in the development of auditory capacities or hypothesis of auditory processing disorder. The distinction between a delay in the development of auditory capacities, and an auditory processing disorder should rely on results of subsequent evaluations. Abnormal results that are consistently seen over time with little or no change suggest the presence of auditory processing disorder, rather than maturational delay. Improvement in performance over time towards the normal range supports a conclusion of delay in the development of auditory capacities.

It should be emphasized that, although the clinician may not have enough information to differentiate between a maturational delay and a more permanent disorder, intervention is still required. Basing our approach on the ICF model reminds us that our focus needs to be on improving the child's ability to perform the activities of his/her daily life, and his/her ability to participate fully at home, school, and in the community even when we cannot definitively sort out exactly what is happening at the body functions and structures levels.

3.7.2. Re-evaluation

When auditory processing delay/disorder has been identified, re-evaluations at least every two years, are strongly recommended. Yearly evaluations may be more appropriate for young children in whom substantial maturation may be seen, or for children enrolled in formal intervention programs, to monitor progress. Tools presently available for the assessment of auditory capacity allow a clear distinction between delay and disorder to be made only on the basis of comparison between results of two or more evaluations. Students who evidence a change in their classroom performance or auditory performance, or children who display any other unusual symptoms should be considered for re-evaluation more frequently as the situation warrants.

3.8. Intervention to improve participation

When the ICF clinical codes and checklists are used by clinicians, the ICF addresses its ethical use – "…(1) that persons should be viewed as having inherent value and autonomy, (2) that persons and/or their advocates should have a right to understand how the ICF is being used to classify their functioning and subsequently be able to see their individual ICF codes and their ratings to be given and the right to discuss, challenge, or affirm them, and (3) that ICF codes should never become a label for the person but only a description of specific levels of functioning" (Annex 6). While not incorporating the use of clinical codes, practices in this area should nonetheless mirror these principles, in that children and families should be viewed as having inherent value and autonomy, that children and families should clearly understand assessment results and resulting recommendations which have been developed with their input and consideration, and that our descriptions, reports and recommendations should not represent labels, but rather, comprehensive approaches to improving child and family functioning in all areas of their lives. Designing such a comprehensive approach cannot be based solely on the results of a decontextualized assessment of auditory capacity (BSA, 2011b; Hickson, 2009b).

The ICF framework conceptualizes an individual's ability to participate fully in school, work, social, family and community activities as an interaction between the individual's capacity limitations and his/her contextual factors. Contextual factors within the ICF model refer to environmental factors (factors in the individual's external environment that may impact on his/her functioning) and personal factors (factors in the individual's internal world that may impact his/her functioning). Environmental Factors include not only aspects of the physical environment (such as high noise levels or many reverberant room surfaces), but also aspects of social and communication functioning (such as the use of communication repair strategies by parents or teachers, the use of facilitative teaching strategies in the classroom, etc.). Personal factors include those that are stable (age, gender, personality, first language acquired, etc.) as well as those that might be adaptable (such as coping strategies, motivation, self-concept, self-esteem, advocacy skills, etc.).

While the ICF provides a more detailed breakdown of contextual factors, with related codes and the inclusion of qualifiers to quantify degree of difficulty, it is not the intention of these guidelines to rewrite or tailor these codes and qualifiers to practice in this area. The discussion of contextual factors more broadly allows clinicians and other consumers of these guidelines to conceptualize a comprehensive management approach. A frequent comment in the clinician survey from speech-language pathologists and educational audiologists (and from experience, from classroom teachers and school staff as well), was that the rationale for management recommendations was often not explained, that school staff did not understand management recommendations, or that management recommendations were inappropriate or not implementable in a typical classroom. Use of the ICF contextual factors communicates to parents, school staff, and others, that a comprehensive approach to management is a two-pronged approach. It requires consideration of how to improve/maximize the child's external communication environment (physical and social environmental activities) and how to improve/maximize the child's personal capacities/skills in order to better cope with difficulties in processing auditory information (personal activities).

Under the category of environmental factors, physical environmental activities are defined as activities that will improve the listening environment (including reducing noise, improving signal to noise ratios, and reducing the effects of distance and reverberation), to ensure that students are able to clearly hear and understand auditory information in the classroom.

Social environmental factors refer to activities in which individuals in the child's environment (parents, caregivers, teachers, etc.) can engage to scaffold the child's understanding of auditory information. These include activities such as modeling effective communication repair strategies, or giving in-service training to school staff on the nature of the child's processing difficulties.

Under the category of personal factors, personal activities are considered to be activities designed to improve auditory capacity by direct training, and activities designed to improve a child's ability to cope with difficulties in auditory processing.

The intervention model developed for these guidelines is summarized in Figure 2.

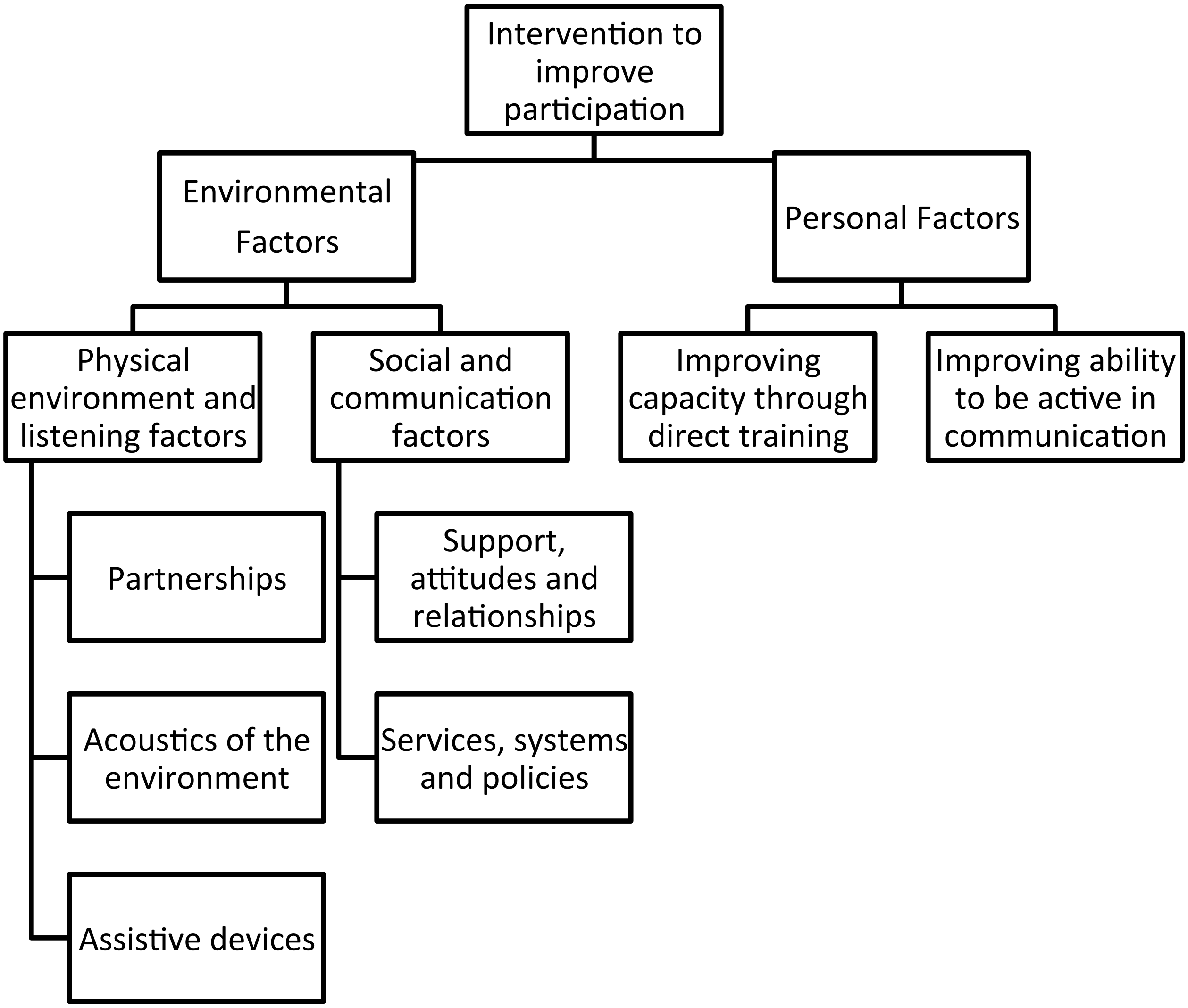

Figure 2. Model for intervention to improve participation for individuals with auditory processing disorder.

3.9. *Environmental factors to improve participation*

3.9.1. *Physical environmental factors*

There is no doubt that improving the classroom listening environment will improve the classroom learning environment, not only for the child with processing difficulties, but for all students. Three areas may be considered – addressing the classroom ecology through partnership with the classroom teacher, improving the listening environment, and trialing assistive listening devices.

3.9.2. *Partnership with the classroom teacher and school staff*

Strategies may be implemented to address classroom ecology to create a listening and learning environment that is effective for all students. This includes ensuring that teacher(s) and students understand the importance of creating a classroom in which effective, cooperative learning can occur. Classroom teachers and school professionals, such as educational audiologists, can work with students on awareness of noise and its effects in the classroom, and brainstorming ways to reduce noise levels that are simple and cost effective. These might include closing the classroom door, talking sticks, using sounds such as a rain stick to signal the need to attend, jotting down important information (such as PA announcements and homework) on the board, implementing student agendas/home books for all students, etc. These strategies are intended to improve the classroom listening environment as a whole, for both teacher and students

3.9.3. Acoustics of the environment

Research consistently indicates that the listening environment in typical classrooms does not meet recommended standards for noise and reverberation for children (Leavitt & Flexer, 1991; Knecht, Nelson, Whitelaw & Feth, 2002; Picard & Bradley, 2001; Zannin & Marcon, 2007). An excellent interactive online resource for information about classroom acoustics was developed by Dr. J. Smaldino and can be found at http://www.projectreal.niu.edu/projectreal/modules.shtml

While information on the types of acoustical modifications that can be implemented in schools is readily available and clear standards for acoustical performance criteria have been written (ANSI, 2002; 2010a, 2010b; New Zealand Ministry of Education, 2007), structural modifications are typically expensive and unlikely to occur at the school level. Recommendations for classroom modifications such as the use of absorptive materials, carpets, or drapes must be considered within the context of health-related concerns for some students (such as those with allergies), fire codes, and the ability to adequately clean classrooms. However, audiologists can and should continue to advocate for better acoustical design in schools and public spaces, and more consideration to universal design for hearing.

3.9.4. Assistive listening devices

Within an ecological model, assistive listening devices represent one tool in an audiologist's toolbox that may (or may not) be effective in improving a child's participation. The body of research-based evidence for the use of assistive listening devices such as personal FM systems or sound field systems, is still small. A comprehensive literature review yielded studies which relied on case study data, employed clinic-based measures rather than classroom-based outcome measures (e.g., speech perception scores in a sound room), and included very small sample sizes. The research literature particularly lacks guidance in the interpretation of test scores or profiles to assist clinicians in predicting which children might benefit from assistive listening devices. However, in the context of the ICF framework and an ecological model, recommendation of assistive listening devices must be based on consideration of activity and participation and contextual factors. Information must be gathered to evaluate how and where participation in activities where auditory processing is required is being limited or adversely affected. Similarly, information regarding facilitative or negative contextual factors at home and school must also be considered (e.g., classroom noise levels, curriculum demands, teaching strategies already in place, etc.). This requires collaboration between clinic and school, with the involvement of families.

Clinicians who recommend assistive listening devices have the obligation to research and evaluate new technologies, to be competent in the use of these technologies themselves and to be knowledgeable about the issues of funding and maintenance of assistive technology (Pell, Gillies & Carss, 1999). When making specific recommendations for assistive listening devices, the clinician must carefully match the technology to the child, the child's needs, the settings in which it will be used, and child/family factors such as motivation. Particularly in educational settings, while assistive listening devices can be useful, they may also pose a social barrier, or create self-esteem and self-confidence issues (Lupton & Seymour, 2000). Therefore, recommendations for assistive listening devices should be made when both clinical and classroom environment assessments provide a rationale for trial of technology, not as a standard recommendation for every child. Speech perception testing with the assistive device (if a personal FM system is being considered) with and without background noise in the clinic can yield some measure of benefit from this technology. However, again, it should be stressed that these measures are not being conducted in a situation that is representative of the typical classroom environment; they are decontextualized measures.

Pre- and post-trial teacher and child questionnaires and checklists provide further information with respect to validation of the assistive listening device fitting. Such questionnaires and checklists can provide information regarding how and when the device is being used, and whether functional improvements in listening are seen with use of the device; they can also serve to engage teachers and/or older students to be active participants in decision-making and management processing, as they should be.

Based on the clinician survey, at present a variety of models for the provision of assistive technology exist, some of which designate teachers of the deaf and hard of hearing or speech-language pathologists as the professionals responsible for assistive technology services. Where educational audiologists are employed by, or consult to, school boards, recommendation of assistive technology falls under their scope of practice. From the online survey, in fact 28% of speech-language pathologists reported that their school boards do not provide FM systems at all for students identified with auditory processing disorder. Some speech-language pathologists reported inconsistent school board practices in this area, in that where no formal policy was in place, services may or may not be provided based on parent and teacher knowledge and advocacy. Where assistive listening devices are provided, fitting of personal FM systems is infrequently performed by educational audiologists and much more commonly by teachers of the deaf/hard of hearing and speech-language pathologists, often simply using manufacturer default settings. Therefore, the importance of developing relationships with community partners such as schools, and understanding their processes and practices cannot be overstated, to ensure that where assistive listening devices are implemented, the systems are installed/fit correctly, that school staff are adequately in-serviced on using and checking the technology and that changes in student performance with the technology are appropriately documented.

Documentation of the need for assistive listening technology, validation of its benefit, and ongoing evaluation of its continuing need is crucial. As discussed in the section on assessment, some children show evidence of a maturational delay upon reassessment, and eventually demonstrate auditory processing skills within the normal range. Use of assistive listening technology must also be evaluated regularly to determine if continued use is indicated, or if changes to the ways in which the technology are used is needed. This information also needs to be relayed back to the clinical audiologist, for documentation, to provide valuable feedback to clinical audiologists who are typically not able to directly observe the effects of management recommendations in the classroom, and to enhance the collaborative process.

Given the number and complexity of variables involved in recommending a specific assistive technology for use in the classroom, recommended best practice is for collaboration between clinical and educational audiologists, where the clinical audiologist is responsible for clinic-based assessment and the educational audiologist is responsible for overseeing and managing classroom-based assessment, and determining need and eligibility. Educational audiologists should also conduct or oversee the selection and fitting/installation of assistive technology, assessment of benefit, and monitoring of ongoing use and need for the technology. Given the reality of a severe shortage of educational audiologists in Canada, it is understood that implementation of this model is not possible everywhere at present; however, to best meet the needs of students with auditory disorders (including those with hearing loss), increasing the number of educational audiologists in Canadian schools must be a top priority for the profession.

3.9.5. Social environmental factors

The ICF includes three categories entitled "support and relationships," "attitudes" and "services, systems and policies," which will be grouped loosely to address social environmental factors.

3.9.6. Support, relationships and attitudes

A large part of providing support to children with auditory processing disorder focuses on facilitating listening, learning and communication through the provision of facilitative communication strategies by adults. At school, this support often falls under the category of accommodations. In education, the difference between *accommodations* and *modifications* is important. *Accommodations* are changes to the way that the curriculum is provided, while keeping the content of the curriculum unchanged – these include strategies such as preferential seating. These might also include the use of teaching strategies such as repetition, rephrasing, comprehension checks, etc. The important point is that the student receives the same educational program and curriculum as the other students in the class, with the addition of helpful strategies or technology. *Modifications* to a student's program mean that the content of the curriculum, and/or expectations of the student, have been changed. This might mean alternate tests or assignments; for example, a student in grade 6 who is working at a grade 3 reading level with grade 3 reading materials. Recommendations for accommodations can and should be made in auditory processing assessment reports; however, decisions regarding modifications to the curriculum and provision of support personnel (such as educational assistants) are always made at the school and school board level in partnership with parents and incorporating all relevant student information.

It is important that recommendations regarding accommodations be relevant and appropriate to the child's educational context. For example, ensuring that a child can see and hear both the teacher and his/her classmates clearly is always helpful; however, the recommendation "preferential seating" is not always understandable in many of today's classrooms, where seating arrangements are not organized in "traditional" rows and where a child's seat may change frequently throughout the school day in response to changing activities.

A primary focus must always be on eventually shifting some of the responsibility for repairing communication and learning breakdowns from the adult to the child. Children can be helped to learn to identify difficult listening environments and situations, and taught compensatory strategies that they can implement themselves. Techniques and programs for teaching children strategies to repair communication and learning breakdowns are readily available. For example, something as simple as implementing use of a student agenda that is first consistently checked by both teacher and parent, and then gradually expecting student responsibility for this task each day can be extremely effective in preventing communication breakdowns and misunderstandings, and in improving a student's organizational and self-advocacy skills.

3.9.7. Services, systems and policies

In Canada, it is important to recognize that "auditory processing disorder" may or may not be included in the criteria for provision of specific special education services. In Ontario, for example, identification of an auditory processing disorder alone does not qualify a student for additional support services other than those available at the individual school level for any student experiencing difficulty. These services are available based on student needs, however, not as a result of an identification of auditory processing disorder (Millett & Ross, 2010). In Quebec, formal identification of an auditory processing disorder is required for children to qualify for services provided by rehabilitation centers.

The clinician survey revealed a very wide range of service delivery models for these students. Guidelines for provision of assistive technology are equally variable across Canada, with some school districts routinely providing assistive listening devices upon recommendation, others providing technology only if students have also had a formal speech, language and psychoeducational assessment, still others providing funding for technology upon evidence of a successful trial period, and others providing technology only when purchased by parents. In the clinician survey, 28% of responding speech-language pathologists and educational audiologists reported that their school board does not provide assistive listening devices at all for students with auditory processing disorder. In order to provide effective recommendations, and to provide accurate information to parents and families, it is important that audiologists have a clear understanding of the educational contexts and policies in their community schools.

The ICF emphasizes the bidirectional relationships among factors in the model – communication amongst those involved with the child, then, is crucial. In many cases, there may be several professionals involved in a child's program. These may include the classroom teacher, a resource teacher, a speech-language pathologist, a school psychologist, a clinical psychologist, an occupational therapist and others, each with his/her own perspective and approach to assessment and intervention. It is important for other professionals to understand the nature and implications of the assessments conducted by the audiologist for the identification of auditory processing disorder (AAA, 2010). However, it is equally incumbent upon the audiologist to understand the nature and implications of assessments conducted by other professionals. This is particularly true when working with children with co-morbid conditions (such as learning disabilities, attention deficit hyperactivity disorders, autism spectrum disorders, etc.), to avoid situations where recommendations from different professionals may be confusing, overwhelming in scope or sometimes even contradictory.

The same principles apply to communication at home and in the community. When we think of difficult listening environments, our focus is often on school. However, it is important to recognize that difficult listening environments (in terms of high noise levels, high reverberation and distance), exist everywhere. At home, listening from another room in the house, and listening while there are auditory distractions such as television or gaming devices are common areas of difficulties for children. In the car, and at sporting events are other locations where children with auditory processing difficulties are expected to listen effectively in the presence of high noise levels, minimal visual cues, distance and reverberation. While as with classrooms, it is often difficult or impossible to implement acoustical modifications to the physical environment, recognition of where and when these types of environments are problematic in a child's life allows family members, coaches and others to implement communication strategies.

Millett (2009) discussed the need for provision of good listening environments in all classrooms for all students by integrating principles of universal design into schools. She advocated for the use of sound field amplification systems in all classrooms as a way to improve student listening, attention and engagement, teacher effectiveness and language learning (Millett and Ross, 2010).

3.10. Personal factors to improve participation

3.10.1. Improving auditory capacities by direct intervention

Research on the effects of direct intervention using auditory training to ameliorate auditory processing difficulties is variable. Moore (2011) notes that psychoacoustic research indicates that it is very possible to demonstrate improvement on a psychoacoustic task when the outcome measure is on capacities but that the research is less clear on whether that improvement will generalize to real world listening performance. Moore cites research from the field of vision and stroke rehabilitation to suggest that neurological change with training is possible, but notes that the pediatric clients with auditory processing disorder bring with them difficulties with complex problems in listening, learning and cognition, along with poor attention and memory. Moore suggests that audiologists should continue to explore auditory training interventions, but notes that "for these complex skills, the most promising method of training would seem somehow to embed highly targeted language skill development in exercises with very high levels of engagement approaches" (p. 307).

The BSA (2011b) guidelines provide a comprehensive and up to date summary and literature review of the variety of direct interventions currently being used, and readers are encouraged to access this document. Interventions reviewed included formal computer based auditory training (Earobics, Fast ForWord, and Phonomena), non-computer based formal auditory training programs (Lindamood program, etc.), using headphones or speakers (the Dichotic Interaural Intensity Difference program, Musiek, 2004), informal dichotic listening and binaural interaction training (Bellis, 2002), informal auditory closure training (Bellis, 2002), informal music training, informal temporal patterning and prosody training, informal phonological and phonemic awareness training and informal interhemispheric transfer activities (Bellis, 2002). This review can be accessed at:
http://thebsa.org.uk/images/stories/docs/BSA_APD_Management_1Aug11_FINAL_amended17Oct11.pdf

Readers are also directed to Fey et al. (2011) for a comprehensive review and discussion of research studies on formal auditory and language interventions for children with auditory processing disorder and spoken language disorders.

3.10.2. Improving the child's ability to be active in communication and learning

There are a large number of strategies which can be implemented by parents, school staff, speech-language pathologists, and others to help a child to (a) cope and to fill in missing information when he/she has missed or misunderstood auditory information, and (b) to become a better listener and advocate for him/herself.

Where children evidence expressive and/or receptive language difficulties, work by speech-language pathologists to address these problems will improve a child's ability to cope when auditory processing difficulties impede the reception of auditory information. Increasing the number and effectiveness of metacognitive strategies available to a child to help attend to, organize and remember auditory information will also be helpful. Strategies such as verbal rehearsal, mnemonics, analogies, chunking, creating mind maps, note taking and visualization can assist children in remembering and organizing information presented verbally.

Teaching children how to be more effective communication partners, and how to repair communication breakdowns, can help significantly. Many children have few or no strategies to implement when they have not understood (other than the nonspecific "huh?" or "what?"). Teaching children how to ask more specific questions, and how to request a communication breakdown repair in an effective and polite way, will reduce the frustrations commonly voiced by adults in the child's life. For example, a nonspecific "huh?" will often result in frustration from the child's communication partner and a complete repetition of the message, whereas a more specific question such as “which question am I supposed to do?” results in provision of the specific information needed. An excellent resource for programs addressing communication breakdown repair for Tye-Murray’s (2009) book *Foundations of Aural Rehabilitation*; Chapter 9 specifically addresses communication strategies training for children.

Teaching a child about factors and situations which adversely affect good listening allows the child to become a better advocate for him/herself, and to assume as much responsibility as possible for his/her learning. Understanding the types of activities and situations that will present obstacles to listening and understanding (for example, high noise levels, feeling tired at the end of the school day, or fast paced classroom discussions) will help children learn how to implement their own strategies (asking to work in a quieter place for individual seatwork, for example) but will also help them understand that their difficulties are not related to a lack of ability, competence, motivation, attention or desire to learn.

CHAPTER 4
ASSESSMENT AND MANAGEMENT OF AUDITORY PROCESSING DISORDER IN ADULTS

4.1. Introduction

The ICF model emphasizes *functional health* and the interaction between an individual's health conditions and the contextual factors around him/her. The origin of the individual's difficulties may or may not be identifiable as a specific disorder of a body function or structure, but we can nonetheless be effective in improving functional health. Adults may present for assessment for a variety of reasons, including difficulty with current job requirements, difficulty learning a new language, as part of a medical work up for neurologic disorder such as traumatic brain injury or simply for disproportionate complaints of hearing difficulties in background noise. The focus of these guidelines is on the functional impact of APD; however, for many adults, the site of lesion within the auditory system may in fact be quite well described. It is also true that site of lesion can sometimes be clearly defined for infants and children (for example, in the case of stroke or brain tumours). This section highlights neurological conditions of which clinicians should be aware because of their potential links to auditory processing disorder.

In order to evaluate the auditory system, audiologists must possess knowledge of the anatomy, physiology and vasculature of the central auditory nervous system. Understanding the neuroanatomical underpinnings of auditory processing is important as an initial starting point. While initial processing begins with the transduction of sound into an electrical impulse that is then carried to the higher structures of the auditory system for analysis and processing, it is generally recognized that the central auditory nervous system begins at the level of the cochlear nucleus (CN). The CN transmits sounds to the superior olivary complex, the first structure to receive auditory input from both ears, then to the inferior colliculus, medial geniculate and subcortical pathways. Subcortical and cortical pathways consist of connections to Heschl's gyrus, the planum temporal and the insula. Both cerebral hemispheres are connected by the corpus callosum, a large band of white matter fibres that has a long maturational component. This band of fibres is responsible for the communication between both cerebral hemispheres.

A discussion on the central auditory system would not be complete without mention of the efferent auditory system. While most of our current knowledge concerning the efferent system comes from research on animals, an appreciation of the workings of the system is just emerging. It has been postulated that the efferent auditory system plays an important role in hearing in noise (Sahley, Nodar & Musiek, 1996). More is known about the medial pathway but to date, clinically useful test methods have been elusive.

Researchers have demonstrated that within the auditory system there exists an asymmetry between important auditory areas within the left and right hemispheres of the brain. Geshwind & Levitsky (1968) found, on postmortem inspection, that 65% of 100 brains had a larger planum temporale on the left side. Wada & Davis (1977) found that 90% of infant and adult brains had left right asymmetries for the 200 brains examined. A comprehensive review of the central auditory nervous system can be found in Musiek & Baran (2007). Note that there is a general finding of reduced hemispheric asymmetry in normal aging, with these changes in functional brain organization being attributed to brain plasticity in response to the compensatory use of information with sensory and cognitive decline (e.g., Cabeza, 2002; Cabeza , Anderson, Locantore, & McIntosh, 2002; Davis, Dennis, Daselaar, Fleck & Cabeza, 2008). Age-related changes in dichotic listening have been documented in the central auditory processing literature (e.g., Jerger, Moncrieff, Greenwald, Wambacq, & Seipel, 2000); however, much more still needs to be learned about how age-related auditory changes in cortical networks relate to other age-related changes in brain organization during information processing (for a review, see Pichora-Fuller & Singh, 2006).

While audiologists receive extensive training in the workings of the peripheral auditory mechanisms, they must also be knowledgeable about disorders that can affect the central auditory nervous system, including, but not limited to cerebrovascular disorders, traumatic brain injury, demyelinating diseases, anoxia, chemical poisoning, etc. Audiologists must be able to translate hearing concerns into workable hypotheses that can be tested using sound scientific principles and a comprehensive test battery approach. For example, audiological testing protocols for disorders that affect the lower brainstem will be different than for disorders affecting higher levels. Besides the typical peripheral hearing battery, those clients suspected of brainstem disorder should receive a test battery that includes measures of acoustic reflexes, auditory brainstem responses and masking level differences. Clients with suspected higher order disorders may involve auditory temporal testing and dichotic speech measures along with middle and late evoked potentials.

4.2. Indications for referral

In the adult population, assessment of auditory processing abilities should be considered whenever there is evidence of:

- the existence of a known neurological event (tumours, stroke, solvent exposure, traumatic brain injury, etc.).
- changes in the adult client's experience of listening (or observations of such by others).
- cognitive decline or dementia.
- unsuccessful implementation of amplification especially in light of a neurologic event.
- vision impairment not correctable by lenses that could disrupt the interpretation of speech or visual world context.

In addition, the growing body of research on age-related changes to the auditory system suggests that clinicians need to be aware of the presence of auditory processing deficits in the aging population.

4.3. Personal factors

This chapter is based on the premise that most cases of auditory processing disorder in adults are acquired (related to a known neurological event) or secondary (accompanying age-related changes), rather than developmental. While it is certainly possible for adults to demonstrate developmental auditory processing disorder which did not resolve with maturation, these clients are expected to represent a much smaller part of most clinical caseloads, compared to adults with acquired or secondary auditory processing disorder.

4.3.1. Age

Loss of hearing sensitivity due to age-related cochlear changes is extremely common; however, the fact that brain function in all areas deteriorates with age must also be considered when working with adults (Hommet et al., 2010; Hopkins & Moore, 2011). One of the virtually universal auditory complaints for adult clients is speech in noise difficulties, with or without elevated pure tone thresholds. These difficulties will aggravate, and be aggravated by age-related changes in vision, cognition, etc.

4.3.2. Cognition

Aging adults are likely to account for a significant part of many audiologists' caseloads, and therefore it is crucial to consider interactions between hearing and cognition with respect to communication difficulties. On the one hand, poor hearing can exaggerate apparent cognitive declines (e.g., people do not remember information heard in noise compared to information heard in quiet even if they can repeat all the words correctly); on the other hand, those with better cognitive abilities cope better with hearing loss, presumably because they can use knowledge and supportive contextual information to compensate when the quality of the incoming sound is poor.

Abundant evidence exists that stored knowledge and expertise is well preserved in healthy older adults. However, language production and comprehension suffer because speed of information processing slows, with associated declines in working memory and attention (for reviews see Kemper, 1992; Wingfield & Tun, 2007). Interestingly, it seems that healthy older adults demonstrate cognitive strengths that may counter-act or compensate for cognitive declines during spoken language comprehension. For example, the ability of older adults to use "environmental support" has been related to compensation on memory tasks (e.g., Craik, 1982). Similarly, various types of linguistic and situational "context" can be used to advantage by older adults to compensate when performing spoken language comprehension tasks in which cognitive processing demands are high (Pichora-Fuller, 2009; Wingfield & Tun, 2007). In general, studies comparing patterns of brain activation in younger and older adults have found that older adults have more widespread brain activation than younger adults when they perform similarly (e.g., Cabeza et al., 2002). In addition, compared to younger adults, in older adults the patterns of brain activation may be less lateralized (Bellis & Wilber, 2001; Bellis, Nichol & Kraus, 2000; Cabeza, 2002) and posterior brain areas may be engaged differently (Davis, Kislyuk, Kim, & Sams, 2008). These age-related changes in brain networks are considered widely to be consistent with compensation, including compensation on tasks such as understanding speech in noise (Wong, Ettlinger, Sheppard, Gunasekera, & Dhar, 2010). Importantly, recent research about brain plasticity is very encouraging for rehabilitation professionals because it suggests that older adults can compensate by finding new ways to successfully perform complex tasks such as listening to speech in noise (e.g., Peelle, Troiani, Wingfield, & Grossman, 2010).

A core assumption of cognitive information processing theory has been that an individual has limited cognitive resources for memory and attention. According to this theory, when information processing becomes effortful, more resources are consumed such that demands on resources for some processes can deplete the resources available to be allocated to other processes. When a person with good hearing listens in ideal conditions that are familiar, quiet and without distraction, listening is largely effortless or automatic and there is little if any drain on the pool of available cognitive resources. Thus, when listening is easy the connection between auditory and cognitive processing is relatively unimportant. In contrast, there can be a direct connection between hearing loss and cognition because, in a limited capacity system, when listening becomes effortful there could be a depletion of cognitive resources such that other processes required for comprehension and/or memory are starved (Pichora-Fuller, 2009). When effortful listening (e.g., due to auditory processing deficits and/or the adversity of the listening condition) diverts cognitive resources away from other types of processing, the apparent cognitive declines in memory, attention, and comprehension that are often observed in older listeners are exacerbated (Kricos, 2006; Pichora-Fuller, Schneider, & Daneman, 1995; Pichora-Fuller, 2003; Wingfield, Tun, Koh, & Rosen, 1999). Consistent with the notion that listening in challenging conditions increases demands on processing is the finding that the ability of older adults to understand time-compressed speech is strongly correlated with measures of working memory involving sequencing (Vaughan, Storzbach, & Furukawa, 2006). Thus, age-related changes in auditory processing can conspire with changes in cognitive processing abilities to reduce the spoken language comprehension of older adults. There can also be an indirect connection between hearing and cognition when a person is multi-tasking. Even if listening does not consume an excessive share of the available cognitive resources, when a person must listen while performing a concurrent task then the combined demands may reduce the cognitive resources available for higher-level information processing; e.g., conversing while driving in traffic or walking with a cane is more resource-demanding than repeating words in a speech recognition test in quiet conducted in a sound booth. In many realistic everyday situations, because the cognitive resources required for listening will trade with the cognitive resources allocated to other tasks, auditory processing interacts with cognition and we are only beginning to understand how to take these interactions into consideration when designing rehabilitation (Arlinger et al., 2009; Pichora-Fuller & Schow, 2012).

Older adults can find themselves ignored or marginalized in social situations because they are unable to keep up with the flow of conversation, or are too slow in comprehending what is being said. Sometimes difficulties in conversation (and the resulting social exclusion) motivate older adults (often at the insistence of their family members) to seek help from specialists. Quite often, however, older adults, and/or their family members, attribute these comprehension difficulties to cognitive declines, and ignore or downplay the possibility that these difficulties may be due, in part, to age-related changes in hearing. The reverse is also common, whereby the problems are attributed to hearing loss and cognitive declines are overlooked. To participate effectively in a multi-talker conversation, listeners need to do more than simply recognize and repeat the words being spoken (speech reception). They have to keep track of who said what, extract the meaning of each utterance, store it in memory for future use, integrate the incoming information with what each conversational participant has said in the past, and draw on the listener's own knowledge of the topic under consideration in order to extract general themes and formulate responses. In other words effective communication requires not only an intact auditory system, but also an intact cognitive system.

Cognitive impairment related to neurological events such as traumatic brain injury, or related to dementia, must be considered in auditory processing assessment and test interpretation. The individual's ability to understand and remember instructions, attend to the listening tasks for the required timeframe, understand and remember the test stimuli, and provide the required verbal or nonverbal response must all be adequate so as not to introduce confounding test variables.

4.3.3. Tumours

Bocca, Calearo and Cassinari, (1954) highlighted the importance of testing "beyond the cochlea" in identifying clients with tumours affecting the temporal lobes. Bocca and colleagues used filtered speech in clients with confirmed lesions and normal peripheral hearing; subsequent research has identified a large number of clinical tests sensitive to the presence of auditory and brain tumours.

Over the years, more sensitive, cost and time effective diagnostic tools in neuroimaging have emerged, and formal auditory processing assessment is rarely considered a part of the diagnostic battery. However, audiologists should still be aware of the possibility of retrocochlear lesions when clients present with normal pure tone hearing but communication complaints, and make appropriate referrals. While neuroimaging tests have emerged as the "gold standard" to detect mass lesions, it is important to recognize the inherent differences between imaging and auditory processing evaluations. Neuroimaging reveals structural deficits within the central auditory system while the auditory processing battery provides measures of the functional component of a disorder. It is therefore necessary for the audiologist to work closely with medical counterparts, physicians, ENTs and neurologists to ensure that any functional limitations on the client's communicative abilities are identified.

4.3.4. Cerebrovascular disorders or stroke

Cerebrovascular disorders or stroke may affect any level of the central auditory nervous system (Bamiou et al., 2006; Hausler & Levine, 2000), with severity of the processing deficit varying depending on size and specific location of the damage. "Central deafness" is a rare condition and was once thought to only occur with lesions in both temporal lobes. However, cases of central deafness have been described by lesions in the brainstem (Hausler & Levine, 2000; Tanaka, Kano, Yoshida, & Yanadori, 1991), inferior colliculus (Hoistad & Haine, 2003; Musiek et al., 2004), internal capsules (Hausler & Levine, 2000), Heschel's gyrus (Musiek et al., 2007; Musiek & Lee, 1998) and the insula (Habib et al., 1995). These reports suggest that such cerebrovascular disorders can impact the central auditory system and examination should be completed by an audiologist with expertise in neuroaudiology. Clients, families and health care providers may not consider an audiological evaluation to be necessary or to be a priority, due to the severity of other sequelae of a stroke. Clients and families may also lack the time, energy and resources required to address hearing and processing difficulties in addition to managing other post-stroke rehabilitation programs. Therefore it is important for audiologists to be included as members of rehabilitation teams.

4.3.5. Traumatic brain injury

Brain injury is, by its very nature, a serious disorder. Clients can display a variety of impairments, including cognitive, language, psychological and sensory deficits, all of which have a detrimental effect on how the individual interacts and communicates (Lew, Jerger, Guillory, & Henry, 2007). Wennmo and Svensson (1989) provide an overview on damage that can occur to the peripheral auditory structures from head injury; however, central auditory pathways can also be affected. While traumatic brain injury (TBI) as a result of car accidents and falls has been the focus in the past, renewed interest has been generated by two groups – veterans returning from conflicts overseas, and athletes suffering sports related concussion (Musiek & Chermak, 2006). It has been estimated that 10–20% of veterans returning from overseas conflicts have traumatic brain injury; and that over 50% of clients with traumatic brain injury may have auditory processing disorder (Bergemalm & Borg, 2001; Musiek et al., 2004).

Evoked potentials have been useful in assessing clients with TBI and perhaps the most studied is the auditory brainstem response (Fligor, Cox, & Nesathurai, 2001). The best predictor of auditory dysfunction seems to be the interpeak latency of I-V, as a measure of conduction time (Bergemalm & Borg, 2001), while middle latency response research suggests the presence of Na Pa amplitude and latency differences. Munjal, Panda, & Pathak (2010) reported that their 290 participants with closed head injury had more middle latency responses abnormalities than ABR abnormalities. Greenberg, Mayer, Becker and Miller (1977) noted that the most common site of pathology for individuals with head injury is above the inferior colliculus, an important site in the generation of wave V of the auditory brainstem response. More recent data from Taber, Warden and Hurley (2006) supports the Greenberg theory, at least when reviewing data from blast related trauma. These researchers suggest that TBI due to blast-related events cause diffuse axonal injuries occurring most often in auditory related areas such as the fronto-temporal areas, the internal capsule, upper brainstem, and corpus callosum.

Audiologists should consider neuroaudiological testing even in the absence of any abnormal imaging studies. While damage caused by TBI can often be detected using brain imaging, it can also fail to detect neural damage (Kaipio et al., 2000; Musiek, Baran & Shinn, 2004). Kaipio et al. (2000)

conducted electrophysiological testing on individuals with closed head injury and complaints of increased distractibility and increased shifting of attention. While there were no documented abnormalities on imaging studies, electrophysiological data was abnormal. Similarly, Musiek et al. (2004) detailed a case of a 41-year-old female suffering from a TBI related to a fall from a horse. Audiological testing indicated auditory processing disorder from both the auditory middle latency response and a detailed behavioural testing paradigm; additionally, the synchrony of the auditory middle latency response was also found to improve in this client following intervention.

Similarly, sports related concussion can have a dramatic effect on processing abilities. Turgeon, Champoux, Lepore, Leclerc and Ellemberg (2011) reported results of auditory processing assessments for university athletes with concussion and athletes without concussion. Of the eight athletes with concussion, five demonstrated auditory processing deficits, despite having normal peripheral hearing, and no complaints of tinnitus. These results suggest that auditory processing deficits can be a potential consequence of sports-related concussion, and that assessment of auditory processing should be considered with these clients.

4.3.6. Epilepsy

Epilepsy is a neurological disorder characterized by a sudden electrical disturbance in the normal functioning of the brain, known as a seizure. In the majority of cases, the cause of the seizure is unknown, but it can develop after infection, stroke, traumatic injury or poisoning. While drug therapy is a common treatment, removal of sections of the brain may be recommended, in rare cases, for intractable seizures. Studies have demonstrated cerebral dysfunction secondary to epileptic activity and many have temporal lobe involvement (Reeves, 1981; Musiek et al., 1990). Earlier research in the area of surgical treatment of epilepsy has shown a standard central auditory profile in individuals with complete commissurotomy (Milner, Taylor & Sperry, 1968; Musiek, Kibbe & Baran, 1984; Musiek, Reeves & Baran, 1985; Musiek, Wilson, & Pinheiro, 1979). With complete sectioning of the corpus callosum, there is an extreme left ear deficit on dichotic tasks for verbal stimuli, abnormal verbal report of temporal patterning testing and normal low monaural redundancy tests. The left ear deficit arises from the fact that in a dichotic condition, auditory information from the left ear must travel to the right hemisphere and then must be shunted to the left hemisphere for the linguistic label, as this is the hemisphere where the language is processed in most right handed individuals (Branch, Milner, & Rasmussen, 1964). This cannot happen due to the severing of the corpus callosum. The abnormal verbal reporting of temporal patterning occurs because processes from both hemispheres are needed; the acoustic pattern must first be recognized in the right hemisphere before it is shunted to the language portion of the left hemisphere for labelling

A key finding in these clients is that the ability to perform low monaural redundancy speech tasks is not compromised by the severing of the corpus callosum, as research indicates that the corpus callosum is not required for this task (Musiek & Baran, 2007). Deep brain lesions affecting the callosum, but not the cortex, will display findings similar to individuals with "split-brain" (Sparks, Goodglass, & Nickel, 1970). Conversely, if a lesion compromises both the cortex and callosal fibres in the left hemisphere, then a bilateral deficit will be seen on dichotic auditory tasks.

There is limited data on auditory evoked potentials in the split-brain population; however, Kutas, Hillyard, Volpe and Gazzaniga (1990) found P300's were not significantly impacted by severing of the corpus callosum. The researchers did notice that the amplitudes for the N2 and P300 binaural grand mean waveforms were larger for the right hemispheres as compared to the left.

4.3.7. *Solvent exposure*

Exposure to industrial chemicals and solvents can be harmful to the central auditory system. Studies have shown a decrease in the performance of central auditory function as measured by a number of behavioural tests and evoked potentials while peripheral hearing measures remain normal (Laukli & Hansen, 1995; Moen, Riise, & Kyvik, 1999; Niklasson et al., 1998; Moller et al.,1989; Odkvist, Arlinger, Edling, Larsby, & Bergholtz, 1987; Odkvist, Moller, & Thuomas, 1992; Pollastrini, Abramo, Cristalli, Baretti, & Greco, 1994; Varney, Kubu, & Morrow, 1998). Musiek and Hanlon (1999) describe a case study of a chemistry professor accidentally exposed to dimethylmercury poisoning. The professor exhibited "word deafness" with largely normal auditory peripheral mechanism; however the auditory brainstem testing revealed significant abnormality. Interestingly, neuroimaging in this case did not detect any abnormality.

Fuente, McPherson, Munoz & Espina (2006) studied auditory processing disorder related to exposure to various organic solvents using a test battery which included standard peripheral assessment, a dichotic digits test, a pitch patterns test, masking level differences, a filtered speech test, a random gap detection test and hearing in noise tests. All subjects had normal peripheral hearing and word recognition scores in quiet. Solvent exposed workers had more difficulty with filtered speech, dichotic digits, pitch pattern tests and random gap detection than non-exposed workers. While there were a number of factors that may have impacted the study, the researchers suggest that the peripheral hearing examination alone is not sufficient to describe auditory complaints in individuals exposed to these materials. Similar reports have revealed findings with exposure to mercury (Dutra, Monteiro, & Câmara Vde, 2010), toluene (Gopal, 2008), and xylene (Draper & Bamiou, 2009).

4.3.8. *Demyelinating disorders and neurodegenerative diseases*

Multiple sclerosis (MS) is perhaps the most common known disorder in this category. According to the Canadian Multiple Sclerosis Society, Canadians have the highest rate of MS in the world and it is the most common neurologic disease in Canada. MS is an unpredictable, often disabling disease of the central nervous system. MS is characterized by intermittent damage to myelin of the nerve cell caused by the destruction of specialized cells that form the substance. The disease attacks the protective myelin covering of the central nervous system, causing inflammation and often destroying the myelin in patches. The client with MS will have well defined attacks followed by complete or partial recovery. The severity of MS, progression and specific symptoms cannot be predicted at the time of diagnosis. Of concern for the audiologist, multiple focal demyelinating plaques have been found to affect the auditory nerve, brainstem, subcortex and corpus callosum. Because the plaques can affect the white matter along the CANS, clients with MS can present with a diverse array of auditory complaints. However, most clients with MS are not sent for complete audiological testing, perhaps due to the fact that hearing concerns are not their most debilitating problem. If a physician fails to specifically question clients about hearing performance, it is unlikely the audiologist will be consulted. If an audiological assessment is completed, often only a peripheral examination will be conducted, and auditory deficits associated with the central auditory system will be missed. Musiek, Gollegly, Kibbe & Reeves (1989) found that 40% of their MS subjects had auditory complaints with normal peripheral hearing; perhaps even more surprising, 80% of their subjects had an abnormality on at least one central auditory test.

Research has indicated that a relatively small portion of clients with MS has peripheral hearing loss (Armington, Harnsberger, Smoker, & Osbourne, 1988). While there have been reports of sudden onset hearing loss as the initial symptom of MS (Cevette, Robinette, Carter, & Knops, 1995; Stach & Delgado-Vilches, 1993), the findings in such cases generally points to a central auditory explanation for the "pseudo-peripheral" hearing loss. That is, the auditory nerve or low brainstem has been affected, as evidenced by an abnormal auditory brainstem response with normal otoacoustic emissions. Further reports suggest neuroaudiological testing, including behavioural and electrophysiological responses, can show the impact of MS on central auditory processing along the entire central auditory nervous system (Hannley, Jerger, & Rivera, 1983; Jerger, Oliver, Rivera, & Stach, 1986; Silman, 1995), subcortical levels (Stach & Hudson, 1990) and interhemispheric pathways (Musiek et al., 1989; Musiek, Baran, & Pinheiro, 1994).

Rance, Corben, Barker, et al. (2010) found evidence of auditory processing disorder in a majority of their subjects with Friedrich's ataxia, a neurodegenerative disorder that affects both motor and sensory systems. They found impaired performance on tests of gap and amplitude modulation detection tests, speech understanding and auditory brainstem response when compared to control groups of normal hearing individuals, and individuals with sensorineural hearing loss but without ataxia.

4.3.9. *Genetics*

There is accumulating evidence for a genetic basis of some forms of auditory processing disorder. Morell et al. (2007) have shown that identical twins have more difficulty with dichotic listening than fraternal twins, leading the researchers to suggest that dichotic listening is a strongly inherited trait. Bamiou et al. (2007) outlined central auditory processing deficits caused by impaired interhemispheric transfer in 11 children with PAX6 mutations (mutations characterized by developmental aniridia and abnormal interhemispheric transfer functions which include an absent or underdeveloped anterior commissure and a smaller corpus callosum). Imaging results reveal abnormalities in the interhemispheric pathway. Peretz, Cummings and Dube (2007) studied families with amusia or tone deafness. In amusic families, 39% of first-degree relatives have the same condition as opposed to 3% of control families leading the authors to suggest that this pitch disorder has a hereditary component.

4.3.10. *Peripheral hearing loss*

In this context, peripheral hearing loss refers to loss of audibility and a reduction in pure tone audiometric thresholds; any type of supra-threshold assessment necessarily involves some level of auditory processing. Difficulty with detection of sound as evidenced by abnormalities on the pure tone audiogram is commonly seen in seniors but can also be seen in younger adults with peripheral hearing loss related to noise exposure, genetic hearing loss, or head injury. Adults presenting for auditory processing assessment may exhibit sensorineural, conductive or mixed hearing loss which may be unrelated to the presumed etiology of the acquired auditory processing disorder (as with occupational noise exposure) or may be related to the presumed etiology (such as hearing loss accompanying head trauma).

Pichora-Fuller (2009) noted that, in aging adults, the blurring of peripheral and "central" auditory systems becomes even more evident, with possible damage to one or more structures in the cochlea and/or the auditory nervous system resulting from many causes, including environmental factors such as exposure to noise and ototoxic drugs, genetic factors, and generalized effects of aging such as cell damage and neural degeneration. Research has identified sub-types of presbycusis based on the particular structures of the auditory system affected by age (e.g., Gates & Mills, 2005; Mills, Schmiedt, Schulte & Dubno, 2006; Schuknecht, 1955, 1964; Schuknecht & Gacek, 1993; Willott, 1991). There is not a straightforward correspondence between damage to particular structures and perceptual deficits, but Pichora-Fuller postulates that damage at multiple sites likely contributes to the differences in auditory processing that are observed between older adults and younger adults who have similar hearing thresholds attributable to more confined pathology.

The AAA (2010) guidelines suggest that while individuals with severe bilateral hearing loss and reduced speech perception abilities are not appropriate candidates for testing, auditory processing assessment could be considered for adults with mild to moderate symmetrical peripheral hearing loss. Tests that are less influenced by sensory hearing loss should be considered, as well as tests developed specifically to be used for individuals with peripheral hearing loss. Electrophysiological testing would also be beneficial for this population. The AAA (2010) guidelines suggest that clinicians should be attentive to reduced test performance in normal hearing ears for individuals with unilateral hearing loss, or asymmetrical performance on behavioural or electrophysiological tests in the presence of symmetrical hearing loss.

Therefore, in contrast to the recommendation previously made for the pediatric population, careful assessment of auditory processing abilities in adults with peripheral hearing loss may be considered, given the generally more reliable and valid normative data available for adults, and the fact that some research literature does exist for this population (Arnst, 1982; Arnst & Doyle, 1983; Dickard, 1988). Recent research suggests a renewed interest in this topic (Jepsen & Dau, 2011; Leigh-Paffenroth, Roup, & Noe, 2011; Lister, Roberts & Lister, 2011).

4.4. Assessment of auditory capacities and performance

4.4.1. Pre-assessment information gathering and case history

It is extremely important that information from clients and families be obtained prior to testing. Responses on the clinician survey from audiologists who work with adults with suspected acquired auditory processing disorder indicated that 68% of audiologists reported that their adult clients were self-referred, compared to 37% reporting referrals from family physicians, 13% reporting referrals from other physicians, speech-language pathologists or other audiologists, and 11% reporting referrals from other health care professionals. It is clear, then, that adults arriving at an audiologist's clinic for auditory processing assessment have found their own way there because of functional communication difficulties. Hind et al. (2011), in a study of 4,757 adults seen for audiological assessment because of reported hearing difficulties, approximately 4% of adults aged 17 to 60 years had normal hearing thresholds. Self-assessment, then, is an integral part of the information gathering process. Self-assessment provides information on the client's perspective and experiences of listening and communicating in his/her daily life at home, work, school and/or in the community, and provides a sense of the impact of listening and communication difficulties on self-concept, self-esteem, motivation, affect, social interaction, job performance, etc.

A variety of checklists and questionnaires have been developed to capture communication difficulties for clients with reported communication difficulties. One example would be the Speech, Spatial and Qualities of Hearing Scale (SSQ) (Gatehouse & Noble, 2004); Abrams (2009) describes many other standardized measures that can be used for this purpose.

Recommendations for information to be gathered during the case history, as recommended by AAA (2010) include

- auditory and/or communication difficulties,
- family history of hearing loss and/or auditory processing deficits,
- medical history,
- educational history and/or work history,
- existence of any known comorbid conditions, including cognitive and/or medical disorders,
- social difficulties related to auditory/ communication difficulties,
- linguistic and cultural background, and

- prior and/or current therapy for any cognitive, linguistic, mental health, or sensory disorder or disability.

Questions regarding cognitive function can be uncomfortable for both clinicians and clients, yet given the increasing numbers of aging adults being seen by audiologists, cognitive health is an important factor. A first step is for audiologists might be to begin to incorporate questions into the case history about cognitive health as well as other age-related health problems that may interface with hearing loss. Audiologists may wish to begin considering the use of screening tools for cognitive impairment if appropriate or practical in their work settings, as do other health care professionals. A number of existing screening tools are in widespread use by health professionals and could be used by audiologists to guide referrals to neuropsychology; the two most common cognitive screening tools are the Mini-Mental State Examination (Folstein & Folstein, 2010) and the Montreal Cognitive Assessment (Nasreddine et al., 2005).

Individuals should be encouraged to obtain, and bring with them, copies of relevant assessments completed by other professionals, such as speech-language pathologists, physicians, rehabilitation professionals, neurologists, etc.

4.5. *Tools for assessment of auditory capacity*

As with pediatric assessments, assessment of the peripheral auditory mechanism is always the first step, and should include pure tone audiometry, immittance battery with both ipsilateral and contralateral acoustic reflexes, speech recognition testing and otoacoustic emissions (OAEs). OAEs, not always routinely included, need to become a staple of every audiological assessment as a direct measure of outer hair cell health. Reports have demonstrated that OAEs are able to detect subtle cochlear damage before the audiogram is affected (Desai, Reed, Cheyne, Richards, & Prasher, 1999; Korres et al., 2002; Pisani et al., 2011). It is therefore possible to have normal audiometric thresholds and absent otoacoustic emissions. While audiograms can provide a cursory view of inner ear health, OAEs provide a direct measure of outer hair cell integrity.

For adults, measuring speech in noise should be part of a standard assessment in clients with reported difficulties. It is not possible to predict this difficulty from the audiogram or speech recognition scores obtained in quiet (Carhart & Tillman, 1970; Killion & Niquette, 2000; Plomp, 1978; Wilson, 2003). Age-related declines in auditory temporal processing associated with neural-type presbycusis may explain the very common complaints of difficulties with speech perception in noise that are reported by seniors with normal hearing thresholds (Gates, Feeney & Higdon, 2003; Pichora-Fuller & Souza, 2003) and assessing this ability allows clients to be put on a rehabilitation path early. The Hearing in Noise Test (HINT) (Nilson, Soli & Sullivan, 1994), Words in Noise Test (WIN) (Wilson & Burks, 2005) and QuickSin (Killon, Revit, & Banerjee, 2004) have shown promise in quantifying hearing in noise problems.

There is little research delineating an appropriate auditory processing test battery for adults. Musiek et al. (2011) note that "use of multiple tests can potentially reduce diagnostic error by improving efficiency, increasing the face validity of the battery as a whole by incorporating a broader range of auditory processes, and providing guidance in establishing the most appropriate intervention goals and program planning" (p. 343). However, they also note that increasing the number of tests in a battery also increases the potential for false positives (i.e., identifying an individual as have an APD, when they do not), and increases cost. Therefore, when choosing the components for a test battery, we must ensure that it meets the following two criteria:

1. It adequately identifies the presence of APD (requiring careful choice of individual tests with good test sensitivity, specificity and efficiency and clear pass/fail criteria), and

2. It assesses and describes the individual's functional difficulties related to auditory dysfunction (requiring some individualization of the test battery to the complaints and functional difficulties reported).

With respect to accurate diagnosis of the presence of APD, test sensitivity, specificity and efficiency must be measured. Sensitivity refers to the ability of a test to correctly identify individuals who do have a disorder, as having that disorder. Specificity refers to the ability of a test to "pass" individuals who do not have the disorder. Test efficiency is measured by the percentage of individuals classified correctly (true positives and true negatives). The usual research methodology used for adults to establish a "gold standard" has been that of comparing performance of a group of individuals with confirmed auditory disorders (e.g., acoustic neuromas or brain tumours) against a control group of neurologically normal individuals. In a study of adults with known neurological lesions, Musiek et al. (2011) found frequency patterns and dichotic digits to have the best test efficiency of the four-test battery they evaluated (which also included the Competing Sentences Test and Filtered Speech Test), when a criterion of performance at two standard deviations below the mean was used.

Humes (2008) reminds us that careful consideration should be given to the use of auditory processing tests which use speech stimuli with aging adults, because of the potential confounding effects of high frequency hearing loss (i.e., presbycusis), and age-related decreases in attention and memory.

Capacities to be assessed can include temporal sequencing/ordering, which can be assessed by tests such as Pitch Patterns Sequence Test (Musiek et al., 1990), and Duration Pattern Test (Musiek & Pinheiro, 1987); identification of speech in degraded listening situations (including listening in noise) which can be assessed by tests such as Synthetic Sentence Identification – Ipsilateral Competing Message (Jerger & Jerger, 1974), filtered speech, time compressed or reverberant speech (Keith, 2002); understanding low redundancy speech (such as low pass filtered speech or compressed speech with reverberation); binaural separation which can be assessed by tests such as competing words, or the Synthetic Sentence Identification –Contralateral Competing Message test (Jerger & Jerger, 1974); binaural integration which can be assessed by tests using dichotic stimuli presentation [e.g., digits (Musiek, 1983), words (Meyers et al., 2002), and sentences (Musiek, 1983; Fifer et al., 1983)] or the Staggered Spondaic Word Test (Katz, 1962); binaural interaction which can be assessed by tests such as the Masking Level Difference Test; localization and lateralization which can be assessed by tests such as the Listening in Spatialized Noise Test (Cameron & Dillon, 2007; Cameron et al., 2009); temporal resolution, which can be assessed by tests such as the Gaps in Noise Test (Musiek et al., 2005), and the Random Gap Detection Test (Keith, 2000); auditory attention which can be assessed by tests as the Auditory Continuous Performance Test (Keith, 1994); and auditory memory which can be assessed by tests such as digit span or expanding memory tests.

Electrophysiology testing may be considered to complement behavioural assessment (e.g., auditory brainstem evoked response, middle latency response, late latency response, Mismatch Negativity, P300). Cases where electrophysiological testing may be valuable include confirming an abnormal finding on behavioural measures, or obtaining information where limited behavioural assessment information can be obtained. Additionally, obtaining evoked potentials may be prove useful to track remedial efforts after training.

4.6. Interpretation of auditory capacity test assessment

Diagnosis of abnormal performance on tests of auditory processing must be based on the cut-off scores or performance criteria provided by the test manual (commonly defined as performance deficits of at least two standard deviations below the mean), on at least two tests. ASHA (2005) recommends that where results of only one test are used to diagnose auditory processing disorder, stricter criteria of performance deficits on one test of at least three standard deviations below the mean and reported significant functional difficulty in auditory behaviours reliant on the process are appropriate. However, it must be acknowledged that these criteria represent only our best interpretation of an evolving research literature on the selection and use of clinical test batteries, and that we must continue to re-evaluate and revise our thinking as we learn more. Recently, a research team representing the National Acoustics Lab, Hearing Cooperative Research Centre and the University of Queensland in Australia (Dillon et al., 2012) provided an excellent review and critique of current use of the test battery approach, and propose an alternative, hierarchical, adaptive mode. This model has as its first step the careful delineation of the functional problems that an individual has with listening in difficult conditions; once this has been described, a two-step testing process including a master battery and a detailed battery is proposed. These authors challenge us to expand our conceptualization both of the disorder, and our approach to identifying it and providing effective management services to our clients.
As previously noted for children, while the literature on test profiles is not definitive, when poor or inconsistent performance on all tests of auditory processing is seen, clinicians should be cognizant of the strong probability of disorders which are more global in nature, and less likely specific to the auditory channel (ASHA 2005).

4.6.1. Re-evaluation

For adults with acquired auditory processing disorder, it is also possible to see improvement in auditory processing skills in some clients (those with traumatic brain injury, stroke, or after removal of brain tumours), and deterioration in auditory processing skills in others (those with neurodegenerative disorders, multiple sclerosis or epilepsy). Therefore, when auditory processing disorder has been identified, re-evaluations at least every two years are strongly recommended. More frequent evaluations may be more appropriate for some clients, particularly for those enrolled in direct auditory training programs, when changes in auditory performance are seen or if the client has a condition whereby there is fluctuation in auditory abilities.

In the aging population, increased difficulty in communication is likely to be seen as a consequence of changes in audition, auditory processing, cognition, vision, and other areas. Monitoring these changes is important for two reasons; first, to provide ongoing accommodations and updates to amplification and the individual's rehabilitation program. Second, since changes in auditory processing and communication can also be early warning signs of dementia, monitoring is important so that appropriate referrals to neurology and neuropsychology can be made.

4.7. Intervention to improve participation

When the ICF clinical codes and checklists are used by clinicians, the ICF addresses its ethical use – "…(1) that persons should be viewed as having inherent value and autonomy, (2) that persons and/or their advocates should have a right to understand how the ICF is being used to classify their functioning and subsequently be able to see their individual ICF codes and their ratings to be given and the right to discuss, challenge, or affirm them, and (3) that ICF codes should never become a label for the person but only a description of specific levels of functioning" (Annex 6). While not incorporating the use of clinical codes, practices in this area should nonetheless mirror these principles, in that clients and families should be viewed as having inherent value and autonomy, that clients and families should clearly understand assessment results and resulting recommendations which have been developed with their input and consideration, and that our descriptions, reports and recommendations should not represent labels, but rather, comprehensive approaches to improving individual and family functioning in all areas of their lives. Designing such a comprehensive approach cannot be based solely on the results of a decontextualized assessment of auditory capacity (BSA, 2011). Furthermore, outcome measures are used in research to establish the evidence base upon which new programs are introduced into practice and/or old ones are changed or phased out. During counselling and when discussing treatment options with a client, the audiologist should share current research evidence regarding various treatments so that the client can make informed decisions when planning care (Hickson, 2009a).

The ICF framework conceptualizes an individual's ability to participate fully in school, work, social, family and community activities as an interaction between the individual's capacity limitations and his/her contextual factors. Contextual factors within the ICF model refer to environmental factors (factors in the individual's external environment that may impact on his/her functioning) and personal factors (factors in the individual's internal world that may impact his/her functioning). Environmental factors include not only aspects of the physical environment (such as high noise levels or many reverberant room surfaces), but also aspects of social and communication functioning (such as the use of communication repair strategies by family members, the use of facilitative strategies at work etc. Personal factors include those that are stable (age, gender, personality, first language acquired etc.) as well as those that might be adaptable (such as coping strategies, motivation, self-concept, self-esteem, advocacy skills etc.).

While the ICF provides a more detailed breakdown of contextual factors, with related codes and the inclusion of qualifiers to quantify degree of difficulty, it is not the intention of these guidelines to rewrite or tailor these codes and qualifiers to practice in this area. The discussion of contextual factors more broadly allows clinicians and other consumers of these guidelines to conceptualize a comprehensive management approach. A frequent comment in the clinician survey from speech-language pathologists and audiologists was that the rationale for management recommendations was often not explained that other clients, families, medical and rehabilitation professionals did not understand the implications of the disorder or the management recommendations, or that management recommendations were inappropriate or not implementable. Use of the ICF contextual factors communicates to families, employers, rehabilitation staff and others, that a comprehensive approach to management is a two-pronged approach. It requires consideration of how to improve/maximize the individual's external communication environment (physical and social environmental activities) and how to improve/maximize the individual's personal capacities/skills in order to better cope with difficulties in processing auditory information (personal activities).

Under the category of environmental factors, physical environmental activities are defined as activities that will improve the listening environment (including reducing noise, improving signal to noise ratios, and reducing the effects of distance and reverberation), to ensure that individuals s are able to clearly hear and understand auditory information in their daily environments.

Social environmental factors refer to activities in which individuals in the environment (family members, caregivers, employers etc.) can engage to scaffold the individual's understanding of auditory information. These include activities such as modeling effective communication repair strategies, or giving in-service training to rehabilitation staff on the nature of the individual's processing difficulties.

Under the category of personal factors, personal activities are considered to be activities designed to improve auditory capacity by direct training, and activities designed to improve the ability to cope with difficulties in auditory processing. The intervention model described in these guidelines is summarized in Figure 3.

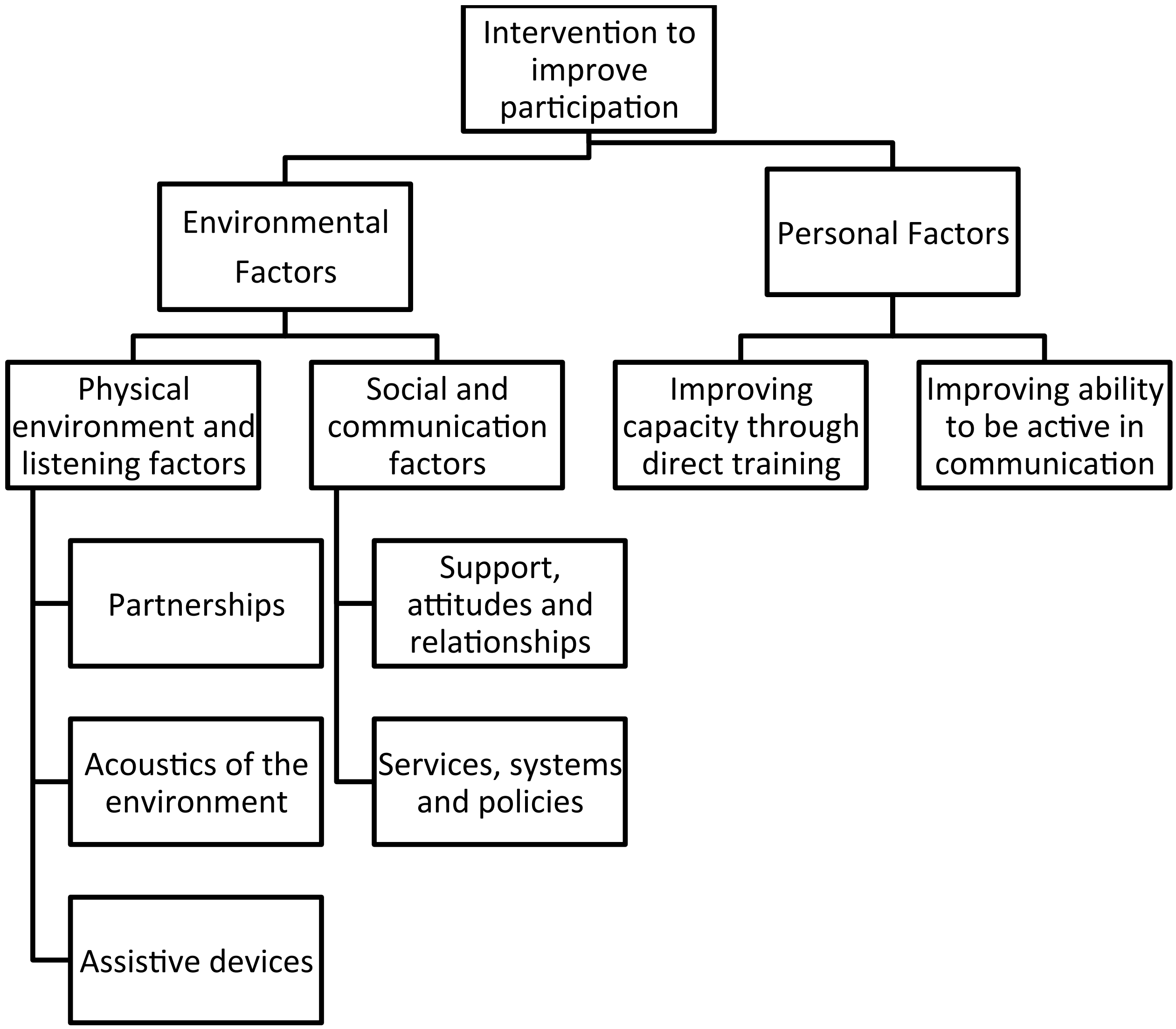

Figure 3. A model for intervention to improve participation.

4.8. Environmental factors

4.8.1. Physical environmental factors

4.8.1.1. Partnerships in the workplace, home and community

Within the ICF model, a primary focus is considering the contexts in which the individual lives his/her everyday life. For children, one of the most important contexts may be school; for adults, it may be the workplace. For adults with acquired APD related to a neurological event, returning to a workplace environment in which they previously functioned effectively and efficiently can be daunting. For aging adults, more gradual declines in auditory processing may begin to impact job performance more and more.

Returning to work following partial or full recovery from a neurological event such as a brain injury or stroke generally comes with a huge increase in communication demands, and therefore a comprehensive interdisciplinary back-to-work transition plan is crucial. Such clients frequently exhibit cognitive communication disorders (CCD), communication impairments resulting from underlying cognitive deficits due to neurological impairment. These are difficulties in communicative competence (listening, speaking, reading, writing, conversation and social interaction) that result from underlying cognitive impairments (attention, memory, organization, information processing, problem solving, and executive functions) (ASHA, 1987). MacDonald & Wiseman-Hakes (2010), in reviewing the literature on CCD listed difficulties typically encountered by individuals with CCD, some of which are clearly linked to auditory processing, including "… impoverished, vague, tangential or disorganized discourse (oral or written), impaired comprehension in the presence of length, complexity, detail, indirect content (implied, abstract, figurative, humorous), background noise, multiple speakers, rapid presentation or rapid shifts from topic to topic, word finding problems particularly in conversation or generative contexts pragmatic or social communication difficulties including problems related to initiation, turn taking, topic management, conversational repair, self-monitoring, social perception and adapting to the needs of the conversational partner and context, and difficulties using language or communication to assist memory and new learning" (p. 487).

Clearly, these difficulties will have a significant impact on an individual's ability to function at home and in the community, but particularly upon returning to the workplace. Interventions for these clients require programs and strategies addressing both contextual and personal factors, and partnerships with many professionals, and individuals in the client's life. For adults with CCD, a comprehensive practice guideline for clinicians has been developed for Ontario that addresses remediation within the ICF model, and serves as a valuable resource for clinicians (CASLPO, 2002).

Another useful resource discussing challenges for vocational rehabilitation for such clients can be found in Scollon (2000). This resource was an initiative with the Workers Compensation Board of British Columbia, which reviewed 600 articles on return-to-work issues. This report made 19 practice recommendations related to vocational re-entry. While this report focused on issues related to traumatic brain injury, many of the points are relevant for individuals working towards return to work after other neurological events. Issues particularly relevant to clinicians working with clients with acquired APD include the findings that

- there are no clear predictors of back to work success at present,
- recovery from traumatic brain injury continues at least two years post injury, highlighting the importance of ongoing assessment,
- the availability of vocational rehabilitation programming is often limited,

- early intervention is beneficial is improving re-employment rates,
- brain injury rehabilitation should be multi-faceted and
- professionals need to be sensitive to relationships between inability to return to work, and social isolation

While vocational rehabilitation considerations may seem most relevant to younger adults with acquired auditory processing disorder, Kramer (2008) reminds us that with the increase in numbers of aging adults and worldwide trends towards increasing or abolishing mandatory retirement age, vocational considerations for older adults must be considered. They described a Vocational Enablement Protocol, which describes the intersection between the job demands and working conditions of an individual, and the auditory demands of those situations from a multidisciplinary perspective that includes otolaryngology, audiology, occupational medicine, social work, psychology and speech-language pathology.

Partnerships with the health care system are crucial for both younger and older adults with auditory processing disorder. For example, adults with acquired APD resulting from traumatic brain injury or stroke may have a large team of professionals participating in their care, and consequently, a large amount of information to absorb, understand and implement, and a large number of appointments and interactions to manage. Similarly, seniors are likely to have a range of health issues in addition to communication problems, making it difficult to interact with the health care system. This problem is complicated by the fact that seniors with communication problems may avoid interactions with others, and experience social isolation, putting themselves at risk for other problems. Losing engagement with family and community because of communication problems jeopardizes the mental and physical health of younger and older adults.

4.8.1.2. Acoustics of the environment

Given the variety of acoustical environments that adults may find themselves in over the course of a day, providing effective improvement of the physical acoustics of an environment is extremely challenging. Information on the detrimental effects of poor room acoustics is widely available in the audiology research literature. In long-term care facilities, for example, there are often significant obstacles to effective and engaging communication amongst residents, including inadequate considerations of common room acoustics, lighting and furniture arrangement. More than 30 years ago, Plomp and Duquesnoy (1980) described the acoustical requirements for seniors to be able to hear effectively and how they differed from the requirements for younger adults, yet it is not clear that there is any more consideration being given to architectural design for optimal room acoustics in long term-care facilities today.

While information on the types of acoustical modifications that can be implemented in buildings and public spaces such as houses of worship, auditoria, meeting rooms etc. is readily available, structural modifications are typically expensive and unlikely to occur when addressed at the individual building level. However, clinicians may be able to identify important or particularly difficult listening environments in partnership with caregivers, and work towards implementing compensatory strategies in these situations. Advocating for appropriate acoustical conditions in public spaces can perhaps more effectively be addressed in the universal design model at the services, systems and policies level of the ICF, as described below.

4.8.1.3. Assistive listening devices

There is no doubt that improving the signal to noise ratio in a communicative exchange under adverse listening conditions has a positive impact on speech perception, although research on the use of assistive listening devices for adults with auditory processing disorder without hearing loss is extremely limited. Rance, Corben, Du Bourg, King, and Delatycki (2010) studied the results of a six week trial with personal FM systems (with binaural ear level FM receivers) for a group of 10 children and adults with Friedreich's ataxia and auditory processing disorder. They found a mean speech identification score in noise of 43% for their subjects without the FM system, and a mean speech discrimination score of 69% with the use of the personal FM system, as well as positive reports on the Abbreviated Profile of Hearing Aid Benefit. While the authors noted that subjects still demonstrated difficulty with speech perception in their daily lives, use of the personal FM system provided significant benefit in improving quality of life for these individuals.

There is a small amount of research literature on the use of FM system for adults with hearing loss, indicating benefit in speech discrimination abilities and ease of communication (Fitzpatrick, Fournier, Séguin, Armstrong, Chénier, & Schramm, 2010; Lewis, Crandell, Valente, & Enrietto Horn, 2004; Schafer & Thibodeau, 2004; Thibodeau, 2010). Chisholm, McArdle and Doynton (2009) studied 36 older veterans on the use of personal FM systems in conjunction with personal hearing aids, and reported better outcomes on speech perception, self-report of communication improvement and satisfaction with the technologies when personal FM systems were used. They also noted that the majority of their clients elected to continue using the FM system at the end of the study; this is in contrast to studies that report a lack of motivation to continue with the technology. Chisholm et al. attributed their positive results to comprehensive coaching, counselling and instruction, which used verbal, text and role playing presentations of the information.

As with children, however, the majority of the research literature focuses on improvements in clinical measures of speech perception, with fewer outcome measures or discussion of the use of FM systems in real world communication contexts. For adults, despite observable benefit, issues related to cost, compliance, management of extra amplification devices, and willingness to use a visible device, appear to represent significant obstacles for many individuals (Boothroyd, 2004; Chisholm, Noe, McArdle, & Abrams, 2007; Jerger, Chmiel, Florin, Pirozzolo & Wilson, 1996; Lewis, Valente, Horn, & Crandell, 2005).

While discussions of the use of technology for individuals with auditory processing disorder typically focuses on FM or infrared systems, other technologies may also be useful. Closed captioning of television programs is a technology readily available on television programs and media (DVDs, Blu-ray, etc.). Television programs and movies can be difficult to follow because there are often other people in the room (creating noise), because visual cues such as speech reading can be difficult to access, and because audio tracks such as music can interfere with hearing speech. Adults with acquired auditory processing disorder, but intact or relatively intact literacy skills may find close captioning to be a useful technology. Gordon-Salant and Callahan (2009), in a study of older adults with poor speech recognition scores, found significant improvement in speech understanding when captioning was added to television programs, and found the best results when both captioning and hearing aids were used. Closed or Rear Window captioning may be available in public movie theatres; information on availability of these technologies can often be found on websites.

Captioning technology for web-based media (such as online video viewing) is still in its infancy, but holds promise for helping those with hearing and processing difficulties. Similarly, understanding voice mail messages at home and work may prove challenging for adults with acquired APD, although technologies such as Google Voice which transcribe voicemail into text, show promise as viable alternatives. Downloadable applications for devices such as Apple or Android, products that provide voice mail transcription, are also beginning to emerge.

When auditory processing disorder occurs with peripheral hearing loss, particular care needs to be given to the prescription and fitting of hearing aids. Souza and Arehart (2006), and Souza (2009), postulated that different signal processing techniques may be appropriate for older hearing aid or cochlear implant users than for younger users; Humes and Dubno (2010) noted that restoring full audibility of the speech signal with amplification is necessary, but may still not result in the same outcomes for older adults than for younger. Some research studies have suggested a reduced ability to benefit from interaural difference cues for older adults (Dubno, Ahlstrom & Horwitz, 2008), and others suggest that individuals demonstrating both reduced audibility and auditory processing problems may be more successful with monaural than binaural amplification (Chmiel, Jerger, Murphy, Pirozzolo, & Tooley-Young, 1997; Walden & Walden, 2005). However, research on differential fitting strategies for older and younger adults does not yet yield much clinical guidance.

4.9. Social environmental factors

4.9.1. Support, relationships and attitudes

A large part of providing support to adults with acquired auditory processing disorder focuses on facilitating listening, learning and communication through the use of metalinguistic and metacognitive strategies to be implemented by both the client and his/her communication partners. Understanding by family members of the nature of auditory processing disorder and its resultant communication difficulties is crucial; as in the case of having a family member with hearing loss, interpersonal and social relationships can easily become strained, and social isolation is a real possibility.

A primary focus must always be on eventually shifting some of the responsibility for repairing communication and learning breakdowns to the client. Adults can be helped to learn to identify difficult listening environments and situations, and taught compensatory strategies that they can implement themselves. Even those living in long-term care have been shown to benefit from this approach (Robertson, Pichora-Fuller, Jennings, Kirson, & Roodenburg, 1997).

For adults with acquired auditory processing disorder, it is important to recognize that often there are related physical, emotional or psychological factors (for example, related to a stroke or traumatic brain injury) that need to be considered and accommodated.

For seniors, provision of services in long-term care facilities presents a number of challenges, including the high prevalence of complex health and communication needs among residents, the high workload demands and poor understanding of auditory disorders by staff, and presence of physical environments that are not conducive to communication. In fact, Hickson (2009a) noted that given the daunting challenges in providing traditional audiological care to residents of long-term care facilities (e.g., fitting of personal hearing aids), it may be more effective in these situations to shift our focus from individual factors to the individual's environment. She argued that "treating the environment more will have great benefits for all individuals" (p. 120). "Treating the environment" would include providing more effective staff training, a greater focus on assistive listening devices than on personal hearing aids, and improving both the physical and social environment of the facility.

4.9.2. Services, systems and policies

The WHO (2002) notes that using the ICF framework allows clinicians to effect change at several levels, including at the societal level (for eligibility criteria to ensure fairness and equity, for social policy development, for population needs assessments and for environmental assessment for universal design, identification of barriers and making changes to social policy). There is no doubt that one of the barriers to rehabilitation for adults with acquired auditory processing disorder is the lack of funding for treatment; this was identified in the clinician survey by a number of audiologists working with adult clients. Clinicians need to advocate for financial support from employers, insurance companies and other bodies so that adults can access the services they need to improve their communication skills and ability to function effectively in their everyday lives, at home, at work, and in the community.

Along with advocating for financial support for clients, audiologists need to be active in advocating for, and developing models of service delivery to support, the availability of services in contexts where we might predict to find adults with auditory processing disorder (such as long-term care facilities and rehabilitation centres). While it has been often reported that providing audiological care to residents of long-term care facilities is very challenging, Lewsen and Cashman (1997) found that hearing aids and assistive listening devices were in good working order and used consistently by seniors when on-site audiological services were provided. Similarly, Pichora-Fuller and Robertson (1997) described positive outcomes for residents and staff when on-site services are provided in an ecological model; teasing out the strategies and technologies that would helpful in the chapel versus those needed for watching TV or attending teas in the auditorium requires the audiologist to have the type of thorough understanding of the listening and communication problems of residents developed through time onsite interacting with staff and residents.

Given that so many of the challenges encountered by adults with acquired APD are similar to those encountered by adults with hearing loss, organizations for adults with hearing loss are excellent sources of information about accommodations, advocacy, strategies and technology for communication difficulties. Consumer groups such as the Canadian Hard of Hearing Association (CHHA) or the Hearing Loss Association of America (HLAA) can provide valuable information and support for adults with auditory disorders.

Jennings (2009) discussed the need for employers and institutions to implement universal design principles into consideration of public environments. She described the need for an occupational approach, defined as an approach that is "focused on what people do, need to do, and want to do in community and public environments, as well as what constrains participation. An occupational approach considers the complexity of interactions between the person, the environment, the occupation/activity and objects" (p. 251). Clinicians are necessarily focused on the individual communication needs of clients in their own particular circumstances; however, there is also a need for audiologists to advocate for change at what Jennings terms the "macro" level, at the institutional and government level. Despite the publication of recommendations in this area by the Canadian Hard of Hearing Association in 2008, and despite the large research literature defining the characteristics of good acoustical environments and the availability of suitable technology, initiatives and motivation to removing barriers to hearing and communication in public spaces in a universal design model appear limited.

4.10. Personal activities to improve auditory performance

A key difference between acquired and developmental auditory processing disorder as described previously (BSA, 2011) is that clients with acquired APD generally demonstrated typical speech, language and cognitive skills prior to developing auditory processing difficulties, and therefore have linguistic competence, world knowledge and metacognitive strategies acquired over their lifetime which might be tapped into to reduce communication difficulties.

However, cognitive information processing theory also suggests that improving listening through addressing personal factors has collateral benefits. According to this theory, individuals have a finite capacity for memory, attention and information processing. Therefore, demands on resources for some processes can deplete the resources available to be allocated to other processes. When a person with good hearing listens in ideal conditions that are familiar, quiet and without distraction, listening is largely effortless or automatic and there is little if any drain on the pool of available cognitive resources. In contrast, when listening conditions are difficult, the pool of available cognitive is drained by listening, leaving fewer resources for spoken language comprehension, memory, attention, and multitasking (Pichora-Fuller, 2007). If we can improve an individual's ability to listen and understand more effectively and with less effort under a variety of circumstances, more cognitive resources may be available for comprehension and memory.

4.10.1. Improving auditory capacities through direct training

There is a growing body of research suggesting that improvement of auditory processing skills through direct training in individuals with APD is possible. Most audiological work has focused on auditory discrimination, dichotic and temporal processing tasks (Kraus, 1999; Moncrieff & Wertz, 2008; Musiek & Schochat, 1998; Tallal, Merzenich, Miller, & Jenkins, 1998; Tallal et al., 1996; Tremblay & Kraus, 2002; Tremblay, Kraus & McGee, 1998). It is not yet clear, however, which factors are important in predicting client success. Although some training techniques offer suggestions for selecting appropriate clients (Baran, Shinn, & Musiek, 2006; Moncrieff & Wertz, 2008), further research is needed.

Key to the concept of such direct training is plasticity or the neural reorganization that results in the auditory system with changes in external stimulation. Research literature on the efficacy of direct training for adults with acquired APD is scarce. However, Musiek, Baran and Shinn (2004) reported a single case study of an individual demonstrating acquired auditory processing disorder associated with a traumatic head injury. This client presented with a variety of self-described and clinical test results consistent with significant communication difficulties associated with her accident. A comprehensive auditory training program consisting of the use of Clear Speech (Picheny Durlach, & Braida 2005), Dichotic Interaural Intensity Difference training (Musiek & Schochat, 1998), an auditory memory enhancement program, speech discrimination training, and temporal sequencing training was implemented, with excellent motivation and participation on the part of the client. The researchers reported that following the training program, improvements were seen both on clinical tests of auditory processing (behavioural and electrophysiological) and on client report of everyday functioning. They suggest that, while spontaneous improvement of auditory processing abilities cannot be ruled out, the fact that there had been no such recovery in the year following the head injury argues for the benefits of the training program.

MacDonald and Wiseman-Hakes (2010), in their review of intervention programs for individuals with acquired brain injury and cognitive-communication disorders, found no research specifically on interventions for auditory comprehension. They noted that this is an important area for research. While treatment goals described by MacDonald and Wiseman-Hakes, such as understanding telephone conversations, language comprehension, and following directions at work etc. may be included in more global treatment plans, there is clearly a role for audiologists in assessment and management of auditory-specific deficits.

Sweetow and Sabes (2010), however, note that provision of direct training programs (in their case to individuals with hearing loss) poses a number of challenges, both clinician-based and client based. They note that generally only a small number of audiologists offer such training programs, and cite possible explanations such as "misconceptions that hearing aids alone are adequate, the lack of belief in outcome measures, belief that additional resources (time, money) are required, lack of reimbursement, reluctance to ask clients to spend more time or money, overcoming inertia, and possibly laziness may be among the reasons accounting for this reluctance. One might predict that audiologists would be more likely to recommend AR [aural rehabilitation] if it produced a lowered return for credit rate from hearing aid purchases." Compliance with the training program was cited as a primary client-based problem. They provide seven recommendations that may improve adherence to, and therefore efficacy of, such programs. These include provision of clear and understandable information about the client's difficulties, simple instructions and treatment regimes, providing follow-up and reminders to clients, listening to and respecting client concerns, and providing reinforcement for compliance with the program (such as extended trial periods or hearing aid batteries), considering clients' attitudes and past experiences, and providing some face-to-face coaching, even for home based programs.

For aging adults, treatments need to be designed to overcome both auditory and cognitive challenges. It is possible that early treatment for hearing loss might not only help to maintain social interaction but that it might also help to stave off or slow down the manifestation of symptoms of dementia. Given the protective effects of physical, cognitive and social activity, it is not surprising that a variety of programs to promote cognitive health in older adults have been developed. Physical exercise has been shown to be beneficial (Colcombe et al., 2006), as has engagement in cognitive activities (Fratiglioni, Paillard-Borg, & Winblad, 2004). Training with a computer-based program to increase cognitive activity has provided encouraging results based on changes in measures on standardized neuropsychological tests (Mahncke, Bronstone, & Merzenich, 2006). Using a group memory intervention for those with mild cognitive impairment, positive outcomes have also been demonstrated, including improvement in memory skills and generalization of their use in everyday life (Troyer, Murphy, Anderson, Moscovitch, & Craik, 2008). Using a social model of health promotion to increase physical, cognitive and social activity, older adults participated in a volunteer program in elementary school. Compared to controls, the volunteers demonstrated cognitive improvements on measures of executive functioning and memory with increased frontal activity during a task involving executive function (Carlson et al., 2008). Volunteers also demonstrated physical improvements on measures of walking speed and grip strength. Social benefits were also realized in terms of an increase in the number of people to whom they felt they could turn to for help.

4.10.2. Improving the individual's ability to be active in the communication process

Reed (2009) stressed the need for a social model of rehabilitation for seniors that very specifically address isolation and the need for interaction and participation in social settings. She noted that the communication difficulties experienced by seniors do not just lead to withdrawal from social interactions (sometimes withdrawal by the individual him/herself but sometimes being excluded by others), isolation, loneliness and depression, but also impact the individual's ability to live independently and manage activities such as shopping, banking and interacting with the health care system. The Hard of Hearing Club described by Reed as implemented at the Baycrest Geriatric Health Care System stands as an exemplary model for a rehabilitation program which address the whole individual; a comprehensive description of the program can be found in the proceedings of the Phonak 2009 conference "The Challenge of Aging" at http://www.phonakpro.com/content/dam/phonak/b2b/Events/conference_proceedings/chicago_2009/proceedings/27_P69344_Pho_Kapitel_15_S147_156.pdf. Other programs developed for aging adults which provide excellent resources for clinicians include the Keep on Talking program (Worrall & Hickson, 2003), Active Communication Education (ACE) (Hickson, Worrall & Scarinci, 2007; Worrall, Scarinci & Hickson, 2007), and the Listening and Communication Enhancement (LACE) program (Sweetow & Sabes, 2006).

There may be other benefits of communication programs that facilitate seniors' abilities to interact and participate with others, and to live engaged, active lives. Pichora-Fuller (personal communication, 2011) noted that:

> Although the intersection of hearing health care with interventions to promote cognitive health has not been investigated, it seems likely that there is a connection. It is well known that those with untreated hearing loss are at risk for withdrawal from social interaction. Participation in social interaction provides opportunities for cognitive stimulation and physical exercise. In order to maintain the active lifestyles that seem to slow cognitive decline, it would be very advantageous to maintain good communication function and social interaction. Thus, successful rehabilitation of hearing impairment may have much broader health benefits.

CHAPTER 5
CONCLUDING REMARKS AND FUTURE DIRECTIONS

There are many challenges still to be addressed in the identification and management of auditory processing disorder in children and adults, and few definitive answers to be found in the research literature. The goal of these guidelines was to propose a conceptual framework within which clinicians could think about how they work with individuals and their families, whether in private practice, hospitals, schools, long-term care facilities, rehabilitation centres or other settings. Through a comprehensive review of the literature, extensive discussions amongst the guideline development team, and consultation with clinicians through the online practice survey, these guidelines emerged with what might be considered an overarching theme of "coordination." These guidelines attempt to wrestle with questions of how to coordinate recommendations from the research literature with the realities of current clinical practice, how to coordinate test results with a client's difficulties in his/her everyday life, how to coordinate information (sometimes contradictory) from interdisciplinary team members, and how to coordinate sometimes fragmented services, to create effective interventions for individuals and their families. The next steps which emerged in the development of this document address three areas – conceptualizing and researching the construct of auditory processing disorder, training clinicians and facilitating continued learning and coordinating interprofessional teamwork and services.

5.1. Conceptualizing and researching the construct of auditory processing disorder

1. Continuing research on the psychometric properties of tests of auditory processing capacities

One of the difficulties in selecting appropriate tests of auditory processing to be included in a clinical test battery has been the scarcity (and in some cases, lack) of adequate psychometric data including test sensitivity, specificity and efficiency. For some tests used clinically, basic psychometric properties of reliability and validity (such as construct validity, concurrent validity, test-retest reliability, inter-test reliability etc.) have not been demonstrated or published. Therefore, an immediate focus must be on the demonstration of basic psychometric properties for commonly used clinical tests.

In addition, in the Canadian context, development and evaluation of tests with appropriate psychometric properties in French is also crucial. While some tests have been adapted or developed in French for use in Canada (Bérard, 1990, 1991; Jutras, Mayer, Joannette, Carrier, & Chénard, 2012; Lagacé, Jutras, Giguère, C., & Gagné, 2010; Lagacé, Jutras, Giguère, & Gagné, 2011; Laroche et al., 2006; Vaillancourt, Laroche, Giguere, & Soli, 2008), this continues to be an area of need to provide services for French speaking clients.

2. Agreeing on the criteria for identifying auditory processing disorder

The lack of agreement in the literature on a set of criteria for identifying an auditory processing disorder continues to be problematic, both from a screening and diagnostic perspective. Individuals and their families need to feel confident that auditory processing disorder will be identified accurately, described comprehensively, and managed effectively by their audiologist, despite differences in geography and local service delivery model. Musiek et al. (2011) recently conducted one of the few studies on sensitivity and specificity of test batteries which provide clinical direction, but more work needs to be done in this area to identify test batteries which provide accurate and comprehensive information about the nature of an individual's auditory difficulties. This includes the role of electrophysiological tests in the clinical test battery.

3. Continuing to develop an ecological model of auditory processing

The focus of research in auditory processing disorder has for many years focused on first, adults with neurological lesions, and then on school-aged children experiencing academic difficulties (many of whom evidence co-morbid conditions such as ADHD, or language/learning disabilities). It is important to recognize other populations for whom emerging or established research has indicated risk factors for auditory processing disorder. These may include seniors, individuals with co-existing sensorineural hearing loss, individuals with traumatic brain injury or military trauma, individuals with dementia, stroke, or other neurological conditions, children with chronic otitis media with hearing loss and children who were preterm.

Arlinger et al. (2009) noted "It may be reasonable for hearing researchers to ignore cognitive factors and for cognitive researchers to ignore auditory factors when they investigate the performance of listeners in ideal listening conditions. However, mounting evidence from behavioural and imaging studies, as well as our everyday experience that listening is sometimes effortful, now compels Cognitive Hearing Science researchers to study the interactions between auditory and cognitive factors when listeners use what they have heard to perform complex tasks such as understanding spoken language in complex auditory scenes." (p. 4). Integrating research from the field of cognitive hearing science into an ecological model such as the ICF allows us to consider the individual within the context of his/her everyday life. Importantly, a re-conceptualization of auditory processing disorder should build on emerging findings from neuroscience that provide new information about how auditory performance relies on various brain networks.

4. Developing an evidence base using outcome measures relevant to activity and participation in everyday life

There are two parts to this recommendation – the first part is the need for more research (the development of an evidence base) on interventions for auditory processing disorder. There is little guidance in the literature to match performance on tests of auditory capacities with effective intervention strategies such as targeted direct training programs or assistive listening technology. As reported in the clinician survey, it is not unusual for recipients of audiological reports (such as speech-language pathologists or teachers), to feel that such reports are generic and do not provide targeted intervention recommendations. Partnerships between clinicians conducting and coordinating intervention programs, and researchers with expertise in research design and interpretation may be a way to link the necessary resources for such research.

The second part of the recommendation is that the outcome measures used in this research must be relevant to activity and participation for individuals with auditory processing disorder. For example, while changes in scores on a speech perception test in a sound-attenuated booth is a perfectly acceptable outcome measure, it does not reflect or predict an individual's ability to be successful at school or in the workplace. The research literature documenting outcomes of rehabilitation programs is distressingly small. There is no doubt that capturing "real world" function and quality of life issues is challenging, particular since many of our clients with auditory processing disorder bring their own challenging personal variables to the research (for example, young children, adults with acquired brain injury or seniors with cognitive decline). The challenges and limitations of standardized, norm referenced clinical tests, or even paper and pencil measures with, for example, adults with traumatic brain injury, or seniors with cognitive impairments, are considerable. Reductions in isolation, depression and loneliness, increases in self-esteem, social participation, independence and happiness are vitally important, yet difficult (and arguably inappropriate) to describe using traditional quantitative research methods. There is a real need for researchers to explore the use of qualitative research methods to effectively capture the effects of interventions on the quality of life of clients with auditory processing disorder. Again, new programs should inform, and be informed by, research on brain plasticity and (re)-training.

5.2. Training clinicians and facilitating continued learning

1. Enhancing opportunities for learning, for practice and for mentorship in academic training programs for audiologists and speech-language pathologists.

An informal survey of Canadian training programs suggested that a substantial amount of information on auditory processing is provided, although often embedded in several courses rather than in a separate course. It may be, however, that practicum experiences may be less widely available to students, particularly in light of the findings of the clinician survey that many audiologists are not offering auditory processing services in their practices and therefore practicum opportunities may be limited. However, given factors such as an expected increase in the size of the aging population, and our increased understanding of how auditory processing disorder impacts many groups of individuals, it is extremely important that this topic continue to be included and stressed in academic training programs for both speech-language pathologists and audiologists. The profession must ensure that future generations of audiologists take a holistic approach to evaluating the individual, and not limit testing to the peripheral mechanism

A combination of theory and clinical mentorship of our newest professionals is needed to ensure that audiology does not become just a technical field but a thriving profession that benefits all those with hearing complaints of any nature.

2. Enhancing effective dissemination of information amongst and between professions, and providing opportunities for continued learning

It is crucial for audiologists practicing in this area to be able to access information on new research findings and perspectives on auditory processing disorder. Given the wide range of clients seen for assessment and management of auditory processing disorder, audiologists should acquire knowledge in related interdisciplinary fields (such as cognitive neuroscience, aging, developmental and cognitive disorders in children etc.). This means that the research literature must be easily accessible to busy clinicians, with the links to implications for practice clearly indicated. Similarly, opportunities for professional development in this area, particularly opportunities for audiologists to share information and clinical experience, can be difficult to find, given geographical, time and economic considerations.

It is important that avenues for information to be shared amongst professionals be available. There are many options that could be explored, including webinars, listservs, videoconferences, publication of research/practice information to a cross-disciplinary audience etc.

5.3. Providing, enhancing and coordinating effective services for clients

1. Advocating for access to services for both assessment and intervention

The online survey conducted during the development of these guidelines indicated that the availability of assessment and intervention services for auditory processing disorder across Canada is extremely inconsistent. While it may seem fruitless to provide assessment services where formal intervention services do not exist, the identification of a health problem is an essential first step to the organization of targeted intervention services. Services will not be developed where no need is perceived. In Quebec, for example, access to rehabilitation services for children with auditory processing disorder has greatly improved in recent years, with one survey indicating that children with auditory processing disorder are now able to access intervention services in at least 11 out of 15 rehabilitation centres in the Province of Quebec, a significant increase in service availability (Patry, Jacques, & Baillargeon 2008).

However, individual and family needs can also be addressed in the absence of formal intervention sites (such as might be available through a rehabilitation centre), through provision of strategies and support, clear and understandable reports, and advocacy. It is important for the audiologist responsible to support the individual and his/her family with a specific intervention plan that helps them to better understand the functional impact of auditory processing disorder. Having a clear, specific, understandable intervention plan can help support the individual even if formal, direct intervention programs or services are not available (for example, for children who are not eligible for specialized educational programs).

Adopting an ecological model in the management of auditory processing disorder also requires the fields of audiology and speech-language pathology to advocate for the provision of services in less traditional practice settings. This includes advocating for more audiologists and speech-language pathologists in schools, long-term care facilities, rehabilitation centres, community care access centres etc.

2. Coordinating interprofessional teamwork and services

One of the most frustrating problems for both children and adults is the fragmented nature of service. Children with auditory processing disorder at school may be alternately served by school resource teachers, speech-language pathologists, teachers of the deaf and hard of hearing, educational audiologists (occasionally) or sometimes by no one. Interprofessional collaboration is often required due to the complex nature of auditory processing disorder and the many co-morbid learning challenges with which it can be associated. However, at the school level, speech-language pathologists and educational audiologists need to be primary point people for these students. The involvement of educational audiologists is crucial where assistive listening devices, particularly personal listening devices (which are a form of personal amplification), are provided. Ng, Fernandez, Buckrell and Gregory (2010), for example, describe a local service delivery model which provides a well-documented process for the evaluation of student needs, and trial of assistive listening device if appropriate, incorporating information from many sources, and which provides a clear, consistent and transparent process for parents.

Fragmentation within health care for adults also exists. Audiologists may refer clients to other professionals (such as otolaryngologists or neurologists) and not receive the results of these assessments, making it difficult to plan an intervention program based on missing information, or an incomplete (or potentially inaccurate) report from the client him/herself. The design and provision of effective rehabilitation programs requires audiologists to have a complete picture of the client, in order to plan rehabilitative actions that are specific to each case and to work collaboratively with other health care providers.

It is hoped that this document has been able to provide audiologists and speech-language pathologists with both a review of the research as it currently exists, and a fresh perspective and framework within which to begin a Canadian discussion amongst audiologists and speech-language pathologists to continue this work.

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