McMaster University | Health Forum

Appendices

Rapid Evidence Profile

Diagnosing central auditory process disorder

5 November 2024

[MHF product code: REP 83]

Appendix 1: Methodological details

We use a standard protocol for preparing rapid evidence profiles (REP) to ensure that our approach to identifying research evidence is as systematic and transparent as possible in the time we were given to prepare the profile.

Engaging subject matter experts

At the beginning of each rapid evidence profile and throughout its development, we engage a subject matter expert, who helps us to scope the question and ensures relevant context is taken into account in the summary of the evidence.

Identifying research evidence

For this REP, we searched ACCESSSS, PubMed, Scopus, GIN, and VA DoD Clinical Practice Guidelines, for:
1) evidence syntheses
2) protocols for evidence syntheses
3) single studies
4) guidelines.

We searched ACCESSSS using an open text search for: “central auditory processing disorder” OR “auditory processing disorder”. Links provide access to the full search strategy. In PubMed and Scopus, we used an open text search for: (“auditory processing”) AND (military OR soldier* OR service*n OR servicewomen OR servicewomen OR veteran* OR army OR navy OR “air force“ OR marine* OR “armed forces” OR “armed services” OR “service member*” OR “military personnel” OR defense AND force OR defence AND force) AND (diagnosis OR diagnostic). In the Guidelines International Network (GIN), we used an open text search for “central auditory processing disorder” OR “auditory processing disorder”.

Each source for these documents is assigned to one team member who conducts hand searches (when a source contains a smaller number of documents) or keyword searches to identify potentially relevant documents. A final inclusion assessment is performed both by the person who did the initial screening and the lead author of the rapid evidence profile, with disagreements resolved by consensus or with the input of a third reviewer on the team. The team uses a dedicated virtual channel to discuss and iteratively refine inclusion/exclusion criteria throughout the process, which provides a running list of considerations that all members can consult during the first stages of assessment.

During this process we include published, pre-print, and grey literature. We do not exclude documents based on the language of a document. However, we are not able to extract key findings from documents that are written in languages other than Chinese, English, French, Portuguese, or Spanish. We provide any documents that do not have content available in these languages in an appendix containing documents excluded at the final stages of reviewing. We excluded documents that did not directly address the research questions and the relevant organizing framework.

Assessing relevance and quality of evidence

We assess the relevance of each included evidence document as being of high, moderate or low relevance to the question.

Two reviewers independently appraise the methodological quality of evidence syntheses that are deemed to be highly relevant using the first version of the AMSTAR tool. Two reviewers independently appraise each synthesis, and disagreements are resolved by consensus with a third reviewer if needed. AMSTAR rates overall methodological quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. High-quality evidence syntheses are those with scores of eight or higher out of a possible 11, medium-quality evidence syntheses are those with scores between four and seven, and low-quality evidence syntheses are those with scores less than four. It is important to note that the AMSTAR tool was developed to assess evidence syntheses focused on clinical interventions, so not all criteria apply to those pertaining to health-system arrangements or implementation strategies. Furthermore, we apply the AMSTAR criteria to evidence syntheses addressing all types of questions, not just those addressing questions about effectiveness, and some of these evidence syntheses addressing other types of questions are syntheses of qualitative studies. While AMSTAR does not account for some of the key attributes of syntheses of qualitative studies, such as whether and how citizens and subject-matter experts were involved, researchers' competency, and how reflexivity was approached, it remains the best general quality-assessment tool of which we're aware. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, an evidence synthesis that scores 8/8 is generally of comparable quality to another scoring 11/11; both ratings are considered 'high scores.' A high score signals that readers of the evidence synthesis can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the evidence synthesis should be discarded, merely that less confidence can be placed in its findings and that it needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7 (Suppl1): S8.)

Preparing the profile

Each included document is cited in the reference list at the end of the REP. For all included guidelines, evidence syntheses, and single studies (when included), we prepare a small number of bullet points that provide a summary of the key findings, which are used to summarize key messages in the text. Protocols and titles/questions have their titles hyperlinked, given that findings are not yet available.

We then draft a summary that highlights the key findings from all highly relevant documents (alongside their date of last search and methodological quality).

Upon completion, the REP is sent to the subject matter expert for their review.

Appendix 2: Details about each identified guidance document

Guidance documents	Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology (CISG) (2012) (1)	New Zealand Audiological Society (NZAS) (2019) (2)	American Speech-Language-Hearing Association (ASHA) (3)	American Academy of Audiology (AAA) (2010)(4)
Definition/ diagnosis	• The guidelines defined auditory processing disorder as being characterized by a persistent limitation in the performance of auditory activities and significant consequences in participation • The guideline notes that this includes challenges with capacity (executive tasks in a standardized environmental) and performance (executing tasks in the everyday environment) • The guideline defines acquired auditory processing disorders as cases that are associated with a known event that could plausibly explain the auditory processing disorder	• NZAS uses the term auditory processing disorder to cover a diagnosis of a range of hearing disorders that result from atypical processing of auditory information in the brain	• The ASHA uses the same definition as the American Academy for Audiology • The guidance document notes that despite its classification there remains no universal reference standard for diagnosing central auditory processing disorder	• The term central auditory processing disorder is used to refer to deficits in the neural processing of auditory information in the central auditory nervous system demonstrated by poor performance in one or more of the following skills: ○ sound localization and lateralization ○ auditory discrimination ○ auditory pattern recognition ○ temporal aspects of audition ○ auditory performance in competing acoustic signals ○ auditory performance with degraded acoustic signals • This diagnosis is in line with the National Center for Health Statistics (U.S.) classification of the diagnosis within ICD-10-CM
Screening	• Case history • Screening tools for cognitive impairment if practical (examples include Mini-Mental State Examination and the Montreal cognitive assessment) • Peripheral auditory capacity assessment ○ Pure-tone audiometry ○ Immittance battery (including both ipsilateral and contralateral acoustic reflexes) ○ Speech recognition ○ Otoacoustic emissions ○ Speech in noise test (such as Hearing Noise Test, Words in Noise Test, and Quicksin)	• The guidance suggests a checklist of symptoms and comorbidities (provided within the guidance) or the use pre-assessment questionnaires, including: ○ CHAPS ○ SIFTER ○ The LIFE-7 ○ TEAP ○ Speech, Spatial and Qualities and Qualities of Hearing Scale ○ Hearing Handicap Inventory for Adults questionnaire • Case history • Direct observation • Audiometric assessment ○ Pure tone audiometry ○ Word recognition in quiet	• ASHA guidance recommends screening prior to comprehensive assessment, which may include an abbreviated test battery, single screening tests, or a combination • No universally accepted method for screening for central auditory processing disorder exists • Case history • Evaluation of peripheral auditory system	• Case history • Direct observation • Self-assessment tools and/or behavioural checklists • Peripheral hearing loss tests ○ Distortion product otoacoustic emissions from 500 to 8000 Hz ○ Immittance measures (tympanometry and acoustic reflexes in uncrossed and crossed stimulus conditions) ○ Pure-tone audiometry with air conduction stimuli ○ Word recognition performance in quiet

Guidance documents	Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology (CISG) (2012) (1)	New Zealand Audiological Society (NZAS) (2019) (2)	American Speech-Language-Hearing Association (ASHA) (3)	American Academy of Audiology (AAA) (2010)(4)
		○ Tympanometry ○ Ipsilateral and contralateral acoustic reflexes ○ Distortion product otoacoustic emissions		
Testing battery	• Auditory processing tests that may be suitable include: ○ temporal sequencing/ordering (pitch patterns sequence test or durations pattern test) ○ identification of speech in degraded listening situations (synthetic sentence identification – ipsilateral competing message) ○ binaural integration (dichotic stimuli presentation or Staggered Spondaic Word Test) ○ Binaural interaction (Masking Level Difference Test) ○ Localization and lateralization (Listening in Spatialized Noise Test) ○ Temporal resolution (Gaps in Noise Test or Random Gap Detection Test) ○ Auditory attention (Auditory Continuous Performance Test) ○ Auditory memory (digital span or expanding memory tests) ▪ Electrophysiology (auditory brainstem evoked response, middle latency response, late latency response, mismatch negativity)	• Auditory processing disorder should be diagnosed alongside a more complete understanding of language, cognition, and other capacities • Auditory processing tests currently most suitable for use in New Zealand for adults include: ○ dichotic listening (Randomized Dichotic Digits Test; Staggered Spondaic Word Test; Competing Words Test; Competing Sentences Test) ○ Distorted speech (University of Canterbury Adaptive Speech Test – Filtered Words, Time Compressed Sentence Test; Filtered Words Test; Northwestern University Auditory Test Number 6 Low-Pass Filtered Speech Test) ○ Speech understanding in background noise (Auditory Figure Grounds Test at 0dB, +8dB and +12dB S/N ratio; Bamford-Kowal Bench Speech in Noise; Words in Noise Test) ○ Spatial segregation (Listening in Spatialized Noise – Sentences Test) ○ Temporal processing (Random Gap Detection Test, gap-in-noise test; Gap Detection Test) ○ Pattern perception (Frequency Pattern Test)	• Evaluation of the central auditory system ○ Tests should be chosen based on age, findings from the case history, interdisciplinary assessment results and results from the peripheral audiologic evaluation, and strengths and weaknesses of the individual tests and population on which they were normed ○ Appropriate measures for auditory processing skills include: ▪ auditory discrimination tests ▪ auditory temporal processing and patterning tests ▪ dichotic speech tests ▪ monaural low-redundancy speech tests ▪ binaural interaction tests • Principles that may influence the composition of a test battery include: ○ refer to the appropriate professionals ○ centre the process around the complaints and relevant information available to the audiologist rather than a test-driven approach ○ include measures that are sensitive to the integrity of the central auditory nervous system ○ examine different central processes, tasks, and the integrity of multiple regions of the central auditory nervous system	• Behavioural tests of specific auditory processes ○ Temporal processes (Gaps in Noise Test; Random Gap Detection Test, Screening Gap Detection Test included in SCAN 3:A and Scan 3:C) ○ Temporal sequencing (Frequency Pattern Sequence Test, Duration Patterns Test) ○ Tests of localization and lateralization and other binaural functions (Masking Level Difference; Listening in Spatialized Noise – Sentences Test) ○ Auditory discrimination tests (Minimal Pairs Test; Wepman's Auditory Discrimination Test) • Auditory electrophysiological tests ○ Speech-invoked auditory brainstem response (however, great evidence on its use for children) ○ Auditory middle latency response ○ Auditory late response ○ Mismatch negativity response

Guidance documents	Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology (CISG) (2012) (1)	New Zealand Audiological Society (NZAS) (2019) (2)	American Speech-Language-Hearing Association (ASHA) (3)	American Academy of Audiology (AAA) (2010)(4)
			○ consider age and developmental status ○ include both verbal and non-verbal stimuli in the testing battery ○ if individuals are taking medication for a related condition, testing should be done while they are medicated to avoid confounding variables ○ monitor attention, motivation, and energy levels	
Diagnostic criteria	• Below 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 • Where only test is used the results should fall three standard deviations below the mean and reported significant functional difficulty in auditory behaviours	• Auditory processing disorder is diagnosed: ○ when an individual presents with scores two standard deviations or more below the mean on at least two different behavioural central auditory tests (with the provision that both tests are monaural and the tests failed may be in the same ear or different ears) ○ if poor performance is reliably observed on only one test with a score two standard deviations below the mean but this is accompanied by significant functional difficulty in auditory behaviours reliant on the process assessed ○ if poor performance is reliably observed on only one test with a score three standard deviations or more below the mean • It is recommended to specify the criteria used to make a diagnosis in case reports	• Current diagnostic criteria and interpretation of test results include: ○ performance deficits are noted in one or both ears of at least two standard deviations below the mean on two or more tests in the battery ○ if poor performance is observed on only one test, diagnosis may be withheld unless performance falls at least three standard deviations below the mean or the finding is accompanied by significant functional difficulty in auditory behaviours that rely on the process being assessed ○ The audiologist should re-administer the sole test failed as well as another similar test that assesses the same process to confirm the initial findings	• Performance deficits of at least two standard deviations below the mean on tests that are known to identify lesions of the central auditory nervous system
Roles and responsibiliti	• The guideline notes that though audiologists have the primary role in diagnosing auditory processing	• The New Zealand guidelines note that audiologists are the only professionals qualified to diagnose	• ASHA suggests a combined approach from audiologists and speech-language pathologists, with:	• AAA notes the diagnosis should be made by audiologists who have been properly educated and trained in the

Guidance documents	Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology (CISG) (2012) (1)	New Zealand Audiological Society (NZAS) (2019) (2)	American Speech-Language-Hearing Association (ASHA) (3)	American Academy of Audiology (AAA) (2010)(4)
es of providers	disorders, they should work as a multidisciplinary team to consider the assessment as well as management and treatment strategies • Members of the multidisciplinary team include speech-language pathologists, educators, psychologists, physicians, and long-term care staff among others • The guidelines also note that audiologists providing a diagnosis should have a clinical knowledge base that is inclusive of auditory processing disorder and knowledge of community resources available to a client	auditory processing disorder and require that they be educated and trained in auditory processing disorder, including the administration and interpretation of tests	○ audiologists responsible for evaluating and diagnosing problems in the reception and/or transference of auditory signals in the peripheral auditory system and central auditory nervous system ○ speech-language pathologists are responsible for evaluating and diagnosing problems in the linguistic processing of the auditory signal • Assessment data may also be shared with other members of an interdisciplinary team such as a psychologist	area of central auditory processing disorder, including the administration and interpretation of tests and procedures • The AAA guideline notes that multidisciplinary assessment complements audiologic diagnosis; these may be completed by speech-language pathologists, psychologists, educators, and physicians

Appendix 3: Details about each identified evidence synthesis

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations
• Diagnosis of central auditory processing disorder ○ Methods for diagnosis of central auditory processing disorder	Each of Children's Auditory Processing Performance Scale (CHAPPS), Amsterdam Inventory for Auditory Disability and Handicap (AIAD), Hyperacusis Questionnaire (HQ), Speech Spatial and Qualities of Hearing Scale (SSQ), and the Auditory Processing Domains Questionnaire (APDQ) demonstrate a strong effect size for accurately separating individuals diagnosed with auditory processing disorder from those without a diagnosis (5) • CHAPPS, AIAD, SSQ, and HQ showed a small to medium effect size for identifying greater deficits in the auditory processing disorder group as compared to those with other clinical diagnoses	High	No	6/9	2023	No	• None reported
• Diagnosis of central auditory processing disorder ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/ psychophysical measures • Temporal processing	Results found three tests – Duration Pattern Tests, Frequency Pattern Tests, and Gaps in Noise Tests – all showed poorer central auditory processing abilities in adults with documented brain pathology compared to normal controls (6)	High	No	9/11	2020	No	• None reported
• Diagnosis of central auditory processing disorder ○ Methods for diagnosis of central auditory processing disorder ▪ Electrophysiological tests ○ Present of comorbidities ▪ Traumatic brain injury • Causality criteria for establishing an association between traumatic brain injury and central auditory processing disorder ○ Strength of association ○ Consistency of evidence ○ Specificity	The evidence synthesis found that traumatic brain injury patients have reduced attentional capacity for processing auditory information (lower amplitude); however, their speed of processing (latency) remains intact compared to health control groups (7) • The evidence synthesis included nine studies examining auditory attention in traumatic brain injury patients compared to healthy controls • Traumatic brain injury patients showed significant lower amplitudes compared to healthy controls demonstrating reduced attentional resources; however, the speed of processing was similar to the healthy control group	High	No	8/11	Published 2023	No	• Personal characteristic s associated with discrimination

Appendix 4: Details about each identified single study

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder • Difficulty localizing sound • Difficulty understanding spoken language in loud/reverberant environments ▪ Family history of hearing loss ▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Binaural interaction (including dichotic listening tests) • Monaural low-redundancy speech tests • Auditory discrimination ○ Presence of comorbidities ▪ Post-traumatic brain injury • Causality criteria ○ Temporal relationship ○ Strength of association ○ Biological plausibility and coherence	Despite reporting normal audiometric thresholds in both groups, the study found that the presence of a traumatic brain injury was an important factor in explaining sensory gating of information, while post-traumatic stress disorder (PTSD) was an important factor in habituation to startle response and when taken together these two factors explained approximately 60% of the variance in performance (8) • The study aimed to explore the relationships between auditory perception and sensory gating in Veterans with high-intensity blast exposure • Study examined 29 combat-deployed Veterans, one group of which had been previously discharged due to blast exposure in the past 10 years and were consistent with having symptoms of a traumatic brain injury while the other group had no history of blast exposure or brain injury • Testing included both self-report measures focused on a medical case history, audiological history, functional hearing questionnaire develop for Veterans with brain injuries, Hearing Handicap Inventory for Adults (to assess the emotional impact of hearing difficulties), and the Neurobehavioral Symptom Inventory to assess post-concussive symptom severity • Behavioural speech perception testing included speech-in-noise test, Consonant-Nucleus-Consonant test, Dichotic Digits Test, Staggered Spondaic Words test, The Compressed Work test • Finally, tests for each habituation and cortical sensory gating were conducted with each of the groups • The study notes that Each of the Dichotic Digits Test, Staggered Spondaic Words test, and the Compressed Work test were explicitly designed for the clinical assessment of Central Auditory Processing Disorder and that previous research has indicated that blast-exposed Veterans performed poorly on these measures	High	Date of publication: 2023 Methods: Cross-sectional study Jurisdiction studied: United States	• Occupation
• Diagnosis of central auditory processing disorder ○ Criteria of diagnostic testing ▪ Presence of occupation exposures	The study recommended the use of extended high-frequency audiometry, CE Chirp auditory brainstem response, Gap Detection Test, and a temporal modulation transfer function based on their ability to detect hidden hearing loss (9) • The study aims to identify hearing tests for hidden hearing loss	High	Date of publication: 2022 Methods: Cross-sectional study Jurisdiction studied: India	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Biaural interaction (including dichotic listening tests) • Temporal processing ▪ Electrophysiological tests • Auditory brain stem response	• The study examined 50 individuals of which 25 were police officers exposed to high levels of occupational noise • However, there are significant limitations to the study namely a lack of longitudinal data and control for confounding variables, and there is no mention of test-retest reliability or comparison to existing testing methods			
• Diagnosis of central auditory processing disorder ○ Criteria of diagnostic testing ▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Self-reported measures ▪ Behavioural/psychophysical measures • Binaural interaction (including dichotic listening tests) • Monaural low-redundancy speed tests • Temporal processes ○ Presence of comorbidities ▪ Post-traumatic stress disorder	Veterans with a history of blast exposure performed poorly on at least one hearing processing tests as compared to the control group; notably, tests that showed the biggest differences between the two groups involved processing timing of sounds and understanding competing speech (10) • The study compares the behavioural auditory tests between those military Veterans that have been exposed to high-intensity blasts at least four years ago to those without blast exposure • The majority (63%) of those with blast exposure showed abnormal performance on at least one of five tests for auditory processing, while only 21% of the control group performed abnormally on the tests • The battery of tests that was run includes an intake assessment consisting of audiometric evaluation, and hearing handicap inventory for adults as well as behavioural tests of central auditory function • Behavioural tests included a gap in noise test of temporal acuity, a Dichotic Digits Test, Staggered Spondaic Words test, Frequency Patterns test, and Masking Level Difference test to measure binaural processing • The test that was found to best differentiate the two groups involved temporal processing and tests of competing speech	High	Date of publication: 2016 Methods: Cross-sectional study Jurisdiction: United States	• Occupational
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Family history of hearing loss ▪ Presence of occupational exposures • Blast exposure	Comprehensive screening involving considering binaural interaction, biological pathologies, and cognitive tests are important for detecting functional hearing loss and communication deficits in active service members (11) • This study estimated the prevalence of functional hearing loss and communication deficits (FHCD) in active service members	High	Date of publication: February 2024 Methods: Cross-sectional study Jurisdiction studied: United States	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Binaural interaction (including dichotic listening tests) • Monaural low-redundancy speech tests • Temporal processing ▪ Electrophysiological tests • Auditory brain stem response • Long-latency auditory-evoked potentials	• In this study, functional hearing loss and communication deficits were characterized by low speech recognition and binaural tone detection • The audiometric, behavioural, cognitive, and electrophysiological measures of active-duty members without a history of blast exposures were compared to those who had a history of blast exposures ○ The control group consisted of 78 participants with auditory thresholds ≤20 dB HL between 250 and 8000 Hz, who passed the FHCD screener ○ The exposed group consisted of 26 individuals with normal to near-normal auditory thresholds between 250 and 4000 Hz, who did not pass the FHCD screener ○ A third, unplanned, group of 11 blast-exposed active-duty members who performed within normal limits on the FHCD screener • The screening measures proved to be effective at detecting differences in those with central auditory processing disorder ○ The screening measures included Speech and Sound Quality (SSQ6), audiogram between 0.25 and 8kHz, tympanogram to help identify potential middle ear pathologies and cochlear pathway function, Woodcock Johnson test battery, the Speed and Capacity of Language-Processing Test, the Rapid Picture Naming Test for Words (RMT), and the binaural masking level difference test (BMLD) • The blast exposed group who failed the FHCD screener performed worse on peripheral and subcortical auditory processing measures • Cognitive processing involving language processing speed and working memory seemed unaffected by blast exposure • The third group performed similar to the control group on peripheral and brainstem processing, but performed more similar to the blast exposed group (group 2) on cognitive processing • Electroencephalogram findings revealed differences in increased spontaneous neural activity, reduced amplitude of the envelope-following response, poor internal signal to noise ratio, reduced response stability, and an absent or delayed onset response in the blast exposed and FHCD group • The findings of this study suggest that blast exposure alone is not sufficient to contribute to FHCD, given the overlap across groups			

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Monaural low-redundancy speech tests	There is no agreed diagnostic testing for auditory and higher level processing in Veterans; however, the Scan-3 measure of auditory processing skills may be able to detect differences in Veterans with and without blast exposure (12) • This study investigated factors that negatively influence auditory and higher-level processing in United States Veterans • This study compared two groups ○ The experimental group included 12 United States Veterans with blast exposure ○ The control group included 6 United States Veterans without a history of blast exposure • All participants completed the following assessments: ○ history of head injuries – The Boston Assessment of Traumatic Brain Injury Lifetime ○ memory skills – Consonant Trigrams Test ○ processing speed – Symbol Digit Modality Test ○ attention skills – Trail Making Test-form A and B ○ SCAN-3 – Auditory processing skills ○ higher level auditory processing skills – Clinical Evaluation of Communication Skills-5 Metalinguistics ○ sentence comprehension – Communication Assessment of Spoken Language • This study revealed that Veterans who did not wear their upgraded helmet during a blast exposure had deficits with inferencing (p=0.04) • The control group showed better higher level language tasks than the blast exposure • Therefore, Veterans that do not have head protecting during a blast exposure are at risk for decreased listening comprehension and inferencing • The group with blast exposure showed auditory processing deficits on the SCAN-3 (p=0.04)	Medium	Date of publication: 15 April 2020 Methods: Cross-sectional Jurisdiction studied: United States	• Occupation
• Diagnosis of central auditory processing disorder ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures	A distinct relationship between mild traumatic brain injury (mTBI) and the onset of central auditory processing disorder was not commented on; however, compared to both the control group and the mTBI-only subsection of the intervention group, patients with mTBI+APD showed an even lower baseline connectivity (13) • The subdivision of the mTBI+APD group was determined using the SCAN-3:A test, for which failing is indicative of APD • This test analyzes temporal processing of tones through gap detection, accurate identification of words amongst noise (figure-	Medium	Date of publication: 2019 Methods: Cross-sectional Jurisdiction studied: United States	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
• Binaural interaction (including dichotic listening tests) • Monaural low-redundancy speech-tests • Temporal processing ○ Presence of comorbidities ▪ Traumatic brain injury ▪ Post-traumatic stress disorder • Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Temporal relationship ○ Biological plausibility and coherence	ground), and binaural listening abilities when competing words are presented to each ear simultaneously • The fMRI test validated lower bilateral auditory cortices activation in mTBI patients and was correlated to the competing words subtest, which suggests the involvement of the central auditory processing system • PTSD and/or post-concussive symptoms may confound the mTBI+APD subgroup results • No confidence intervals between APD and mTBI were reported			
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Presence of occupational exposures ▪ Presence of comorbidities • Anxiety disorder • Traumatic brain injury • Post-traumatic stress disorder • Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Strength of association	Despite having normal audiometric results, Veterans in this study self-reporting hearing difficulties were significantly more likely to have comorbidities, particularly posttraumatic stress disorder, tinnitus, musculoskeletal issues, and anxiety, than Veterans who did not self-report hearing impairment (14) • The 286 Veterans in this study were ages 21–52 and were from conflicts in Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn • The Hearing Handicap Inventory for Adults was used to measure self-perceived hearing handicap, and Veterans self-reporting auditory problems had 14 more prevalent comorbidities than those without (n = 2) • Traumatic brain injury was not found to be associated with self-reported auditory challenges	Medium	Date of publication: January 2023 Methods: Retrospective chart review Jurisdiction studied: United States	• Occupation
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder • Difficulty localizing sound • Difficulty understanding spoken language in	Brazilian gasoline station workers in this study who were continuously exposed to gasoline vapours at work showed poorer audiometric thresholds than the non-exposed control participants at high frequencies than at middle and low frequencies, suggesting that gasoline exposure may have affected the basal part of the cochlea; they also showed poorer otoacoustic emissions suggesting a cochlear dysfunction involving the outer hair cells (15) • An audiological test battery was used that consisted of audiological testing conducted by an audiologist, face-to-face	Medium	Date of publication: April 2019 Methods: Cross-sectional study Jurisdiction studied: Brazil	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
loud/reverberant environments • Difficulty following auditory directions ▪ Presence of occupational exposures • Jet fuel and solvents exposure ○ Health professionals responsible or involved in making a diagnosis of central auditory processing disorder ▪ Audiologists ○ Methods for diagnosis of central auditory processing disorder ▪ Electrophysiological tests • Auditory brain stem response • Long-latency auditory-evoked potentials • Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Strength of association ○ Biological plausibility and coherence	questionnaire, pure-tone audiometry, visual inspection of the ear canal, auditory brainstem response (ABR), transient-evoked and distortion product otoacoustic emissions (TEOAEs and DPOAEs), and P300 auditory evoked potentials • Considering that all the gasoline station workers had normal hearing or sensorineural hearing loss that was no greater than 60 dBHL, the gasoline station workers (n = 77) reported difficulty communicating in noisy places (59.7%), difficulties in communication (20.8%), tinnitus (11.7%), vertigo (11.7%), hearing loss (6.5%), ear fullness (5.2%), earache (1.3%), and sensitivity to loud sounds (1.3%) • They also had significantly worse acoustic reflex thresholds when compared to the non-exposed control group (4kHz (P = 0.01) for the right ear and 0.25 (P = 0.04) and 6 (P = 0.04) for the left ear) and they showed significantly poorer TEOAE signal-to-noise ratios (SNR) (3.5–4.5 kHz in both ears and 4.5-5.5 kHz in the right ear) and DPOAE SNRs than the non-exposed groups in both ears • In terms of ABR, gasoline workers with no hearing loss had wave V absolute latencies that were significantly longer in both ears while gasoline station workers with hearing loss had longer latencies for all ABR waves; this suggests the gasoline station workers may have auditory nerve dysfunction			
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder • Difficulty understanding spoken language in loud/reverberant environments ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/ psychophysical measures	Participants exhibited task-specific deficits on several performance-based tests sensitive to auditory processing, with many scoring more than one standard deviation below the normative mean on speech-in-noise, binaural processing, temporal resolution, and speech segregation assessments; approximately 53% of participants showed abnormal performance on three to six out of 10 measures, supporting that blast injuries can lead to central auditory system damage (16) • 99 blast-exposed Veterans with clinically normal hearing but reported auditory issues in challenging listening environments were assessed using self-report and performance-based measures: ○ Hearing in Noise Test: using SD of 1.3 dB, ~60% performed ≥1 SD poorer than typical listeners, indicating measurable deficits in speech-in-noise comprehension	High	Date of publication: 2015 Methods: Cross-sectional study Jurisdiction studied: Portland, Oregon and Tampa, Florida, U.S.	• None reported

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
	○ Spatialized Noise – Sentences Test: mean performance was lower than younger normal-hearing listeners with 49% scored >1 SD below in spatial advantage, and 16% in talker advantage ○ Adaptive Tests of Temporal Resolution: 57.6% and 34.3% scored >1 SD below the mean in within-channel and across-channel conditions, respectively ○ Time Compressed Speech Test: average scores were higher, with only 3% performing >1 SD below the mean ○ Staggered Spondaic Word Test: 33.7% had abnormally poor scores, with error counts ranging from 0 to 70 and no consistent error pattern observed ○ Digital Span Test: mean scores were below normative data, with 19% scoring >1 SD below the mean ○ Woodcock Johnson Story Recall: average performance, with only 12% scoring >1 SD below the mean, indicating intact working memory for spoken language ○ Stroop Test: average scores for age norms, with only 5% >1 SD below, indicating minimal issues with ignoring irrelevant stimuli			
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder ▪ Presence of occupational exposures • Blast exposure ○ Presence of comorbidities ▪ Anxiety disorder ▪ Clinical depression • Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Temporal relationship	Auditory brain function varied between positive and negative mTBI groups, with those experiencing repetitive mTBIs having larger P50 (an overreaction to basic sounds), and small N100 and N200 (suggesting reduced attention and prioritization of important sounds); however N200 was also influenced by depression and anxiety (17) • This study's objective was to evaluate the relationship between mTBI history, auditory event-related potential (ERP) metrics, and common comorbidities • ERPs from an auditory target detection task, psychological symptoms, and hearing sensitivity were assessed in 152 combat-exposed Veterans and service members (average age 43.6 years) ○ Participants were grouped by positive (n = 110) or negative (n = 42) mTBI history ○ Those with positive mTBI histories were further categorized into repetitive mTBI (3+ occurrences, n = 40) or non-repetitive mTBI (1–2 occurrences, n = 70) • A positive mTBI history was linked to reduced N200 amplitude in response to targets and novel distractors ○ In participants with repetitive mTBI, P50 was larger for nontargets, while N100 was smaller for both nontargets and targets, compared to those with non-repetitive or no mTBI	High	Date of publication: December 2021 Methods: Prospective cohort study Jurisdiction studied: Virginia, U.S.	• None reported

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
	○ N200 changes were influenced by depression, anxiety symptoms, and hearing loss, with no additional direct effect of mTBI observed • Reduced brain responses to relevant and novel stimuli were associated with internalizing symptoms (depression, anxiety) and hearing loss in those with mTBI • Repetitive mTBI was associated with broader impacts on auditory attention and pre-attentive processing, likely due to changes in midbrain and auditory cortex function			
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder • Difficulty localizing sound • Difficulty understanding spoken language in loud/reverberant environments ○ Methods for diagnosis of central auditory processing disorder ▪ Electrophysiological tests • Long-latency auditory-evoked potentials	There is a greater reduction in cortical auditory evoked potential amplitude resulting from background noise in older adults with normal hearing compared to those with sensorineural hearing loss (18) • This study explores the connection between sensorineural hearing loss in older adults and central auditory processing of signals in noise through cortical auditory evoked potentials (CAEPs) • CAEPs were measured for three participant groups with normal hearing (NH), mild hearing loss, and moderate hearing loss at different signal-to-noise ratios (SNRs) ○ Researchers analysed the P1, N1, and P2 peaks of the waveforms obtained • Amplitudes decreased and latencies increased as SNR values decreased • Amplitude of the N1 peaks in the noisy conditions (low SNR) were significantly larger for the hearing loss groups than the NH group • N1 latencies in the moderate hearing loss group were significantly shorter than the NH group	Low	Date of publication: 2023 Methods: Observational cohort study Jurisdiction studied: Turkey	• Age
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Binaural interaction • Monaural low-redundancy speech tests • Auditory discrimination	Diagnostic testing including surveys, audiometric testing, audiometric performance, and hearing questionnaires are important in understanding the prevalence of functional hearing and communication deficits among healthy active service members (19) • This study investigated the prevalence of functional hearing and communication deficits (FHCD) among healthy active-duty service members with normal to near-normal audiometric thresholds and analysed the impact of blast exposure on auditory health • The diagnostic tests used included surveys, audiometric testing, speech in noise (SIN) tests, Binaural Masking Level Difference (BMLD) test, Speech, Spatial and Qualities of Hearing Scale (SSQ6)	High	Date of publication: 2021 Methods: Cross-sectional Jurisdiction studied: United States	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
	• This study estimates that approximately 5.7% of total active-duty service members who were tested are likely to have FHCD (195/3,398 participants) • Of approximately 1.4 million active-duty service members in the United States, an estimated 72,000 service members may be at risk for FHCD			
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Noise exposure that exceeds normal levels • Jets and aircrafts ○ Methods for diagnosis of central auditory processing disorder ▪ Electrophysiological tests	Measures of auditory processing indicated differences between noise-exposed air force crew pilots and un-exposed air force staff whereas audiometry measures did not detect any differences (20) • This study assessed the auditory processing in noise-exposed Royal Air Force crew pilots compared to Air Force administrators with no history of noise exposure • The diagnostic measures used measured both hearing ability and auditory processing • The tests included otoscopy, pure tone audiometry, TEOAEs, suppression of otoacoustic emissions, and auditory processing tests (IMAP Test Battery) • The study found normal hearing thresholds between both groups in audiometry testing but worse performance by the crew pilots in auditory processing tasks • The study suggests that audiometry may not detect significant noise-induced hearing impairment	Medium	Date of publication: 2013 Methods: Cross-sectional study Jurisdiction studied: United Kingdom	• Occupation
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Temporal processing • Auditory discrimination ▪ Electrophysiological tests • Auditory brain stem response • Long-latency auditory-evoked potentials	Comprehensive testing including both behavioural temporal resolution and electrophysiological tests, alongside monaural assessment, are important in understanding the clinical mechanisms underlying auditory deficits (21) • This study assessed temporal processing impairment in blast-exposed Veterans using both behavioural and electrophysiological tests • The study utilized audiometric and self-reporting measures alongside behavioural temporal resolution and electrophysiological tests to assess auditory function • Behavioural temporal resolution testing was assessed using the Gaps In Noise (GIN) Test • Electrophysiological testing included the use of Auditory Event-Related Potentials (AEPs) (P3 Peak and N1 and P2 Responses • This study identified impaired auditory temporal processing and slower cognitive processing in the blast-exposed group compared to the control group	High	Date of publication: 2023 Methods: Cross-sectional study Jurisdiction studied: United States	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
	• Significant left ear GIN scores emphasize the importance of undertaking monaural assessment in auditory testing			
• Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Temporal relationship ○ Strength of association ○ Consistency of evidence ○ Biological plausibility and coherence	Evidence was found for long-term central auditory dysfunction in a subset of civilians with chronic post-concussion symptoms after a single mTBI unrelated to blast trauma (22) • The study was done by administering six behavioural and seven neuropsychological (cognitive) auditory tests to a group with chronic post-concussion symptoms after a single instance of mTBI and a control group • Symptom validity testing was used to assess the rate of possible insufficient test effort and its influence on scores for outcomes, and analyses of group differences in test scores were performed both with and without the participants who showed insufficient test effort to ensure that differences between group performance are not skewed by effort • Peripheral hearing status was similar between groups, and exclusion criteria consisted of defined hearing loss thresholds, preinjury history of neurological disorder, inner ear pathology, learning disability or attention disorder, and more • Most individuals in the mTBI group suffered concussion due to motor vehicle–related accidents (MVA; 38%), falls (22%), assault (9%), sports-related concussion (9%), and other injuries (22%) • The single concussion of each member of the mTBI group was after three months (acute phase) but before 18 months postinjury • The behavioural test battery to identify central auditory processing challenges included monaural word recognition in quiet, binaural word recognition in babble (speech in noise test), Words in Noise Test, time compressed speech (temporal processing), Gaps in Noise (temporal processing) and Staggered Spondaic Word Test • In addition, a self-reported functional hearing questionnaire was provided • The rate of abnormal performance on auditory behavioural tests exceeded the rate of abnormal performance on tests of cognitive function	High	Date of publication: 2019 Methods: Case control study Jurisdiction studied: United States	• None reported
• Diagnosis of central auditory processing disorder ○ Criteria for diagnostic testing ▪ Recent experience of symptoms of central auditory processing disorder	While evidence suggests that lingering blast-induced damage to cortical networks associated with attention can explain communication problems in service members, the comorbidity of PTSD and traumatic brain injury and their overlapping symptomology necessitate further research to isolate the contributions of blast-induced injury on cognitive performance (23)	Medium	Date of publication: 2017 Methods: Cross-sectional study	• Occupation

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
▪ Presence of occupational exposures • Blast exposure ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/ psychophysical measures ○ Presence of comorbidities ▪ Post-traumatic stress disorder	• The study was performed on 14 blast-exposed service members, 12 of which had normal or near-normal hearing range thresholds • Most participants reported issues with selective attention • A pure tone audiometry test and envelop following response test (a type of electrophysiological test) was used to examine peripheral and central hearing followed by a selective auditory hearing test, which is used to examine temporal processing • All participants had also been diagnosed PTSD, but not all had a confirmed mTBI diagnosis • Six participants reported five or fewer blast exposures, while another six subjects reported having 10 or more exposures		Jurisdiction studied: United States	
• Diagnosis of central auditory processing disorder ○ Methods for diagnosis of central auditory processing disorder ▪ Behavioural/psychophysical measures • Temporal processing ▪ Electrophysiological tests • Causality criteria for establishing association between traumatic brain injury and central auditory processing disorder ○ Temporal relationship ○ Consistency of evidence ○ Biological plausibility and coherence	Evidence indicates that subcortical sensory processing may be affected by mTBI on a long-term basis for some, but not all, individuals with chronic post-concussion problems, which suggests that evaluation of populations with mTBI is warranted to identify potential auditory processing difficulty (24) • ABRs and a battery of behavioural audiological tests were collected in 32 individuals diagnosed with mTBI in the past three to 18 months to display brainstem level differences between mTBI and control populations • Subject population was limited to a civilian population who reported ongoing post-concussion problems after three months and up to 18 months after injury • Penetrating trauma, blast, and crush injuries were excluded, along with temporal bone fracture or direct injury to the outer ear • The diagnosis of central auditory processing disorders was not proposed for individuals in this study • Subcortical neural processing differences relate to performance on auditory processing and perception tests, even in the absence of significant hearing loss • Study suggests that the heterogeneity of traumatic brain injury poses an issue for research and clinical practice	High	Date of publication: 2017 Methods: Case control study Jurisdiction studied: United States	• None reported

Appendix 5: Documents excluded at the final stages of reviewing

Document type	Hyperlinked title
Evidence syntheses	Hearing loss and brain disorders: A review of multiple pathologies
Single studies	Comprehensive behavioral and physiologic assessment of peripheral and central auditory function in individuals with mild traumatic brain injury
Non-systematic evidence synthesis	Acquired central auditory processing disorder in service members and Veterans

	The application of the international classification of functioning, disability and health to functional auditory consequences of mild traumatic brain injury
	Acquired Central Auditory Processing Disorder in service members and Veterans

References

1. Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology. Canadian guidelines on auditory processing disorder in children and adults: Assessment and intervention. Ottawa: CISG; 2012.
2. Keith W, Purdy S, Baily M, Kay F. New Zealand guidelines on auditory processing disorder. Auckland: New Zealand Audiological Society; 2019.
3. American Speech-Language-Hearing Association. Central auditory processing disorder [Practice portal]. Rockville, MD: ASHA; n.d. https://www.asha.org/practice-portal/clinical-topics/central-auditory-processing-disorder/#collapse_5 (last visited 7 March 2025).
4. Musiek F, Baran J, Bellis T, et al. Diagnosis, treatment and management of children and adults with central auditory processing disorder. Reston, VA: American Academy of Audiology; 2010.
5. Samara M, Thai-Van H, Ptok M, et al. A systematic review and metanalysis of questionnaires used for auditory processing screening and evaluation. *Frontiers in Neurology* 2023; 14: 1243170.
6. Chowsilpa S, Bamiou DE, Koohi N. Effectiveness of the auditory temporal ordering and resolution tests to detect central auditory processing disorder in adults with evidence of brain pathology: A systematic review and meta-analysis. *Frontiers in Neurology* 2021; 12: 656117.
7. Vanbilsen N, Kotz SA, Rosso M, Leman M, Triccas LT, Feys P, Moumdjian L. Auditory attention measured by EEG in neurological populations: Systematic review of literature and meta-analysis. *Science Reports* 2023; 13(1): 21064.
8. Papesh MA, Stefl AA, Gallun FJ, Billings CJ. Effects of signal type and noise background on auditory evoked potential N1, P2, and P3 measurements in blast-exposed Veterans. *Early Hearing* 2021; 42(1): 106-121.
9. Dhrruvakumar S, Shambhu T, Konadath S. Assessment of hidden hearing loss in individuals exposed to occupational noise using cochlear, neural, temporal functions and quality of life measures. *Indian Journal of Otolaryngology Head and Neck Surgery* 2022; 74(Suppl 1): 524-531.
10. Gallun FJP, Lewis MSP, Folmer RLP, Hutter MMS, Papesh MAP, Belding HBS, Leek MRP. Chronic effects of exposure to high-intensity blasts: Results of tests of central auditory processing. *Journal of Rehabilitation Research and Development* 2016; 53(6): 705-720.
11. Grant KW, Phatak SA, Myers JR, Jenkins KA, Kubli LR, Brungart DS. Functional hearing difficulties in blast-exposed service members with normal to near-normal hearing thresholds. *Ear and Hearing* 2024; 45(1): 130-141.
12. Koebli JR, Balasubramanian V, Zipp GP. An exploration of higher-level language comprehension deficits and factors influencing them following blast TBI in US veterans. *Brain Injury* 2020; 34(5): 630-641.
13. Meehan A, Hebert D, Deru K, Weaver LK. Hidden hearing deficits in military service members with persistent post concussive symptoms. *Undersea and Hyperbaric Medical Society* 2019; 46(3):251-260.
14. Jedlicka D, Zhen L. PTSD is associated with self-perceived hearing handicap: An evaluation of comorbidities in Veterans with normal audiometric thresholds. *Journal of the American Academy Audiology* 2023; 34(9-10): 183-191.
15. Roggia SM, de França AG, Morata TC, Krieg E, Earl BR. Auditory system dysfunction in Brazilian gasoline station workers. *International Journal of Audiology* 2019; 58(8): 484-496.
16. Saunders GH, Frederick MT, Arnold M, Silverman S, Chisolm TH, Myers P. Auditory difficulties in blast-exposed Veterans with clinically normal hearing. *Journal of Rehabilitation Research and Development* 2015; 52(3): 343-360.
17. Manning Franke L, Perera RA, Aygemang AA, et al. Auditory evoked brain potentials as markers of chronic effects of mild traumatic brain injury in mid-life. *Clinical Neurophysiology* 2021; 132(12): 2979-2988.

18. Gürkan S, Mungan Durankaya S. The effect of sensorineural hearing loss on central auditory processing of signals in noise in older adults. *Neuroreport* 2023; 34(4): 249-254.
19. Grant KW, Kubli LR, Phatak SA, Galloza H, Brungart DS. Estimated prevalence of functional hearing difficulties in blast-exposed service members with normal to near–normal-hearing thresholds. *Ear and Hearing* 2021; 42(6): 1615-1626.
20. Hope AJ, Luxon LM, Bamiou DE. Effects of chronic noise exposure on speech-in-noise perception in the presence of normal audiometry. *The Journal of Laryngology & Otology* 2013; 127(3): 233-238.
21. Papesh MA, Koerner T. Clinical gaps-in-noise measures in blast-exposed Veterans: Associations with electrophysiological and behavioral responses. *Seminars in Hearing* 2024; 45(1): 83-100.
22. Vander Werff KR, Rieger B. Auditory and cognitive behavioral performance deficits and symptom reporting in postconcussion syndrome following mild traumatic brain injury. *Journal of Speech Language and Hearing Research* 2019; 62(7): 2501-2518.
23. Bressler S, Goldberg H, Shinn-Cunningham B. Sensory coding and cognitive processing of sound in Veterans with blast exposure. *Hearing Research* 2017; 349: 98-110.
24. Vander Werff KR, Rieger B. Brainstem evoked potential indices of subcortical auditory processing after mild traumatic brain injury. *Ear and Hearing* 2017; 38(4): e200-e214.

Waddell K, Grewal E, Dass R, Ciurea P, Whitelaw H, Goodale G, Bain T, Phelps A, Wilson MG. Rapid evidence profile #83: Diagnosing central auditory processing disorder. Hamilton: McMaster Health Forum, 5 November 2024.

This rapid evidence profile was funded by the Chronic Pain Centre of Excellence for Canadian Veterans and the Atlas Institute for Veterans and Families, which in turn are funded by Veterans Affairs Canada. The McMaster Health Forum receives both financial and in-kind support from McMaster University. The views expressed in the rapid evidence profile are the views of the authors and should not be taken to represent the views of the Chronic Pain Centre of Excellence for Canadian Veterans, the Atlas Institute for Veterans and Families or McMaster University.