The Auditory Processing Battery: Survey of Common Practices

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Abstract

A survey of auditory processing (AP) diagnostic practices was mailed to all licensed audiologists in the State of Maryland and sent as an electronic mail attachment to the American Speech-Language-Hearing Association and Educational Audiology Association Internet forums. Common AP protocols (25 from the Internet, 28 from audiologists in Maryland) included requiring basic audiological testing, using questionnaires, and administering dichotic listening, monaural low-redundancy speech, temporal processing, and electrophysiological tests. Some audiologists also administer binaural interaction, attention, memory, and speech-language/psychological/educational tests and incorporate a classroom observation. The various AP batteries presently administered appear to be based on the availability of AP tests with well-documented normative data. Resources for obtaining AP tests are listed.

Key Words: Attention, auditory processing, binaural interaction, central auditory processing, dichotic listening, memory, monaural low redundancy speech, temporal processing

Abbreviations: ABR = auditory brainstem response; ACPT = Auditory Continuous Performance Test; ADHD = attention-deficit hyperactivity disorder; AFG = Auditory Figure Ground; AFT-R = Auditory Fusion Test-Revised; ALR = auditory late response; AMLR = auditory middle latency response; AP = auditory processing; APD = auditory processing disorder; ARD = acoustic reflex decay; ART = acoustic reflex threshold; ASHA = American Speech-Language-Hearing Association; CAP = central auditory processing; CAPD = central auditory processing disorder; CHAPS = Children’s Auditory Performance Scale; CS = Competing Sentences; CW = Competing Words; DPT = Duration Pattern Test; FW = Filtered Words; MLD = masking level difference; MLR = middle latency response; MMN = mismatched negativity; OAE = otoacoustic emission; NU-6 = Northwestern University Auditory Test No. 6; PBKN = Phonetically Balanced Kindergarten in Noise; PIPB = Performance Intensity for Phonetically Balanced Words; PSI = Pediatric Speech Intelligibility Test; RASP = Rapidly Alternating Speech Perception; SCAN = Screening Test for Auditory Processing Disorders; SCAN-A = A Test for Auditory Processing Disorders in Adolescents and Adults; SCAN-C = Test for Auditory Processing Disorders in Children-Revised; SIFTER = Screening Identification with Contralateral Competing Message; SSI-CCM = Synthetic Sentence Identification with Ipsilateral Competing Message; SSICM = Synthetic Sentence Identification with Ipsilateral Competing Message; SSW = staggered spondaic word; TAPS-R = Test of Auditory Perception Skills; TTFC = Token Test for Children; WRS = word recognition score

Sumario

Una encuesta sobre prácticas diagnósticas de procesamiento auditivo (auditory processing: AP) fue enviada por correo a todos los auditólogos con licencia de ejercicio en el estado de Maryland, y enviada también como archivo de correo electrónico a la American Speech-Language-Hearing Association y a los foros de internet de la Asociación de Audiología Educacional. Los protocolos de AP recolectados (25 de internet y 20 de auditólogos en Maryland) incluyeron elementos en común, como evaluación audiológica básica, el uso de cuestionarios y la administración de pruebas auditivas dicóticas, lenguaje monaural de baja redundancia, procesamiento temporal, y pruebas electrofisiológicas. Algunos auditólogos también administran pruebas de interacción binaural, atención, memoria, y pruebas de habla-lenguaje, psicológicas y educacionales, e incorporan una observación en el aula de clase. Las diferentes baterías AP actualmente utilizadas parecen estar basadas en la disponibilidad de pruebas AP con información normativa bien documentada. Se enlistan recursos para obtener las pruebas AP.

Palabras Clave: Atención, procesamiento auditivo, interacción binural, procesamiento auditivo central, memoria, auditivas dicóticas, lenguaje monaural de baja redundancia, procesamiento temporal

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The topic of auditory processing (AP), also called central auditory processing (CAP) and central hearing loss, has been discussed in the professional literature since the 1950s (Mylkebust, 1954). Within the past decade, a renewed interest in the topic has emerged, including an emphasis on defining, diagnosing, and managing disorders of the central auditory system. In 1995, an American Speech-Language-Hearing Association (ASHA) Task Force on central auditory processing disorders (CAPDs) developed a technical report titled “Central Auditory Processing: Current Status of Research and Implications for Clinical Practice” (ASHA, 1996). The task force defined central auditory processes as

the auditory system mechanisms and processes responsible for the following behavioral phenomena: sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition, including—temporal resolution, temporal masking, temporal integration, temporal ordering; auditory performance decrements with competing acoustic signals; and auditory performance decrements with degraded acoustic signals.

CAPD was defined as “an observed deficiency in one or more of the above-listed behaviors.” One recommendation of this task force was the development of a minimal test battery for assessment of CAPD using physiologic and behavioral tests.

In October 2000, a consensus statement was published on the diagnosis of auditory processing disorders (APDs) in school-aged children (Jerger and Musiek, 2000). The consensus statement included a recommendation to change the traditional label “central auditory processing disorder” to “auditory processing disorder” to emphasize the interactions between the peripheral and central auditory systems. In addition, the consensus statement recommended APD screening procedures and a minimum test battery to differentially diagnose APD in school-aged children.

The recommended minimum test battery included pure-tone audiometry, performance-intensity functions for word recognition, a dichotic task, duration pattern sequence testing, temporal gap detection, immittance audiometry, otoacoustic emissions (OAEs), auditory brainstem response (ABR), and middle latency response (MLR). Optional procedures included comparing auditory and visual continuous performance measures and conducting cortical event-related evoked potential testing.

The publication of minimal test batteries for identifying APD in children is not new (Willeford, 1977; Musiek and Chermak, 1994). In 1994, Musiek and Chermak recommended several first-order tests, including dichotic digits, competing sentences, frequency patterns, and the
Pediatric Speech Intelligibility test (PSI) (Jerger and Jerger, 1984), and second-order tests, including the MLR, the staggered spondaic word (SSW) test (Katz, 1962; Katz et al, 1963), Tallal's tests (Tallal and Percy, 1974), and compressed speech with acoustic modifications, which should be used in diagnosing APD. Similarly, Bellis and Ferre (1999) wrote that "a behavioral [AP] test battery should include at least the following: dichotic speech tasks, monaural low-redundancy speech tasks, tests of temporal patterning, and binaural interaction tasks" (p. 320). More recently, Neijenhuis and colleagues (2001) suggested a seven-test AP battery including words in noise, filtered speech, binaural fusion, sentences in noise, dichotic digits, frequency and duration patterns, and backward masking in addition to the use of a questionnaire. Musiek and colleagues (1982) examined the performance of children with APD on a battery of tests and found that four tests—competing sentences, frequency patterns, dichotic digits, and the SSW—were better at detecting auditory perceptual dysfunction than the Rapidly Alternating Speech Perception (RASP) test (Ivey, 1969; Willeford 1977, 1978), low-pass filtered speech, and binaural fusion.

Individual clinicians often establish site-specific, or individual-specific, protocols. Oliver (1987, cited in Chermak et al, 1998) found that the most commonly reported AP tests for children were the SSW, Willeford Battery (Willeford, 1977) (i.e., competing speech, filtered speech, binaural fusion, and rapidly alternating speech), and speech in noise. Chermak and colleagues (1998) found that the Screening Test for Auditory Processing Disorders (SCAN) (Keith, 1986), acoustic reflex threshold (ART), and ABR were reported as the three most frequently used AP procedures. Martin and colleagues (1998) found that the most commonly reported tests included the SCAN, speech in noise, SSW, and performance-intensity function for phonetically balanced words (PIPB).

The purpose of this study was to investigate common AP diagnostic practices following the publication of the APD consensus statement. A mixed survey (closed- and open-set response format) was developed requesting information on behavioral and physiologic tests used as part of the AP battery in addition to the use of checklists, classroom observation, and tests of memory, attention, and speech-language/psychological/educational ability. The survey was sent via the Internet to audiologists outside Maryland and mailed to all audiologists licensed in the State of Maryland to determine routine AP assessment practices and conformity with the APD consensus statement.

**METHOD**

The survey, titled "Survey of Audiologists' Central Auditory Processing (Auditory Processing) Assessment Battery for Children (Preschool to Age 18)," was posted on the ASHA (<asha-aud-forum@postman.com>) and Education Audiology Association (EAA) (<eaa-list lists.duq.edu>) Internet forums and mailed, with a postage-paid envelope, to all 352 audiologists licensed by the Maryland State Board of Examiners. This survey (Appendix A) included many of the commonly available behavioral AP tests as well as physiologic tests used to identify AP disorders. The behavioral tests were grouped into the following categories: monaural low-redundancy speech, dichotic speech, temporal processing, and binaural interaction (Bellis, 1996; Chermak and Musiek, 1997). Physiologic tests included the immittance battery, OAE, and electrophysiologic tests to examine brainstem and cortical systems. Electrophysiologic tests included the ABR, auditory middle latency response (AMLR), auditory late response (ALR), mismatched negativity (MMN), and P300. Additional survey questions included the use of behavioral checklists, physiologic assessment, auditory attention, classroom observation, auditory memory, speech-language/psychological/educational assessments, and test results from other professionals via referral or on-site team testing.

The respondents' task was to indicate the protocol they use to evaluate AP for their pediatric population (preschool to 18 years old). Each question consisted of a closed set of response options and an open-set response item labeled "other, please specify" because of the large number and diversity of commercially marketed and research tools that can be used as part of the AP battery.

The original intention of the study was to survey audiologists only in the author's home state; however, posting the survey to the Internet allowed for comparison of this localized group with a larger population. Data were not collapsed across the Maryland and Internet groups because of the different sampling procedures and diversity of populations. Responses from the ASHA and EAA Internet forums were collapsed for analysis because the responses were not always identified by group (ASHA vs EAA),
RESULTS

A total of 192 responses (55% response rate) were received from surveys mailed to audiologists licensed in the State of Maryland, and 28 of these (15%) indicated that the respondent completing the survey conducted AP testing. Twenty-seven surveys were received in response to the Internet posting, and 25 responses indicated that the respondent conducted AP testing. The 25 Internet responses summarized for this study were received from the following states/province: Texas (3), Connecticut (1), North Carolina (2), New York (2), Georgia (1), Idaho (1), Colorado (1), Tennessee (1), North Dakota (2), Louisiana (1), Nebraska (1), Florida (1), Illinois (1), Ontario (1), and unknown (6).

All respondents who conduct testing indicated that they were certified and/or licensed in audiology. In addition, eight respondents were also certified and/or licensed in speech-language pathology, one was certified in auditory verbal therapy, and one was certified in deaf education.

General Profile of Test Battery

Figure 1 illustrates responses to survey questions 3 to 14 for both groups and indicates that the general profile of the AP test battery was similar. All of the respondents administer dichotic speech tests and require a basic audiologic assessment prior to AP testing, and 96 percent administer monaural low-redundancy speech tests. In addition, over 60 percent of the respondents from both groups reported the use of questionnaires, temporal processing tests, and information from other professional evaluations (via referral or on-site team) as part of the AP diagnostic protocol. Sixty-four percent of Internet respondents and 46 percent of Maryland respondents indicated that electrophysiologic tests are used in some capacity for AP assessment as part of the standard test battery or as needed. Fewer than 50 percent from either group included binaural interaction, attention, classroom observation, memory, and speech-language/psychoeducational tests as part of their assessment protocol.

The subsequent sections will detail the results of the survey regarding the individual components of the AP test battery. These components include the questionnaire; audiology evaluation; behavioral AP test battery; physiologic test battery; and the findings of the survey regarding assessment of a child's attention, memory, and speech-language, psychological, and educational abilities. A list of all of the AP tests included in the survey, in addition to the AP and speech-language tests provided by respondents, is included as Appendix B along with the current distributors of these tests.

Questionnaire

Most respondents reported that they complete questionnaires as part of the AP battery, although the Internet group used questionnaires more frequently than the Maryland group (84% Internet; 68% Maryland). Figure 2 illustrates that the most popular questionnaires were the...
Children’s Auditory Performance Scale (CHAPS) (Smoski et al, 1998), Fisher Auditory Problems Checklist (Fisher, 1976), and the Screening Identification for Targeting Educational Risk (SIFTER) (Anderson, 1989). Responses in the “other” category included the Kelly checklists (Kelly, 1995), Listening Inventory for Education (Anderson and Smaldino, 1996), and checklists developed by individual testing facilities.

**Basic Audiologic Evaluation**

All of the respondents indicated that basic audiometric results were required prior to AP testing. Figure 3 summarizes the most frequently reported components of the basic audiologic battery. All of the respondents required pure-tone testing and tympanometry. Over 80 percent reported otoscopic examination, word recognition score (WRS), and speech recognition threshold. Only 24 percent (Internet) and 12 percent (Maryland) of the respondents indicated that a performance-intensity function was required, and less than 10 percent from either group reported sentence or nonsense syllable recognition testing.

**Monaural Low-Redundancy Speech Tests**

The most commonly reported tests of monaural low-redundancy speech tests for both groups, illustrated in Figure 4, were the Filtered Word (FW) and Auditory Figure Ground (AFG) subtests of the Test for Auditory Processing Disorders in Children-Revised (SCAN-C) (Keith, 2000) and Test for Auditory Processing Disorders in Adolescents and Adults (SCAN-A) (Keith 1994a). The reported use of these tests ranged from 54 to 68 percent. The FW and AFG subtests of the Screening Test for Auditory Processing Disorders (SCAN) (Keith, 1986) were reported for 43 percent of the Maryland group but for less than 25 percent of the Internet group. Other reported tests of monaural low-redundancy speech, employed less frequently (< 40% of the time), include the Phonetically Balanced Kindergarten (PBK) test (Haskins, 1949) administered in noise, low-pass filtered speech test (e.g., Rintelmann, 1985), Speech in Noise (SIN) test (Fikret-Pasa, 1993; Killion and Villchur, 1993),
The results of the survey indicated that the most commonly reported dichotic tests for both groups, illustrated in Figure 5, were the SSW and the Competing Words (CW) and Competing Sentences (CS) subtests of the SCAN-A and SCAN-C. The SSW was reported by 76 percent of Internet respondents and 57 percent of Maryland respondents. The CW and CS subtests of the SCAN-A were reported by 56 to 64 percent of respondents. The CW and CS subtests of the SCAN-C were also frequently reported, with the Internet respondents more likely to use the CW (60%) and CS (56%) subtests of this test than the Maryland group (50% CW, 43% CS). The SCAN (CW only) was reported by 43 percent of the Maryland group but only 24 percent of the Internet group (34%). The use of dichotic digit testing was common for the Internet group (60%) but much less frequently reported by the Maryland group (18%).

The most frequently reported test of gap detection in the current study was the Auditory Fusion Test-Revised (AFT-R) (McCrosky and Keith, 1996). It is almost exclusively employed by a small group of Internet respondents (28%), with very few reported from the Maryland group (4%). Less than 20 percent of the respondents reported conducting any other listed test. “Other” reported tests in this category included the Screening Test for Auditory Perception (Kimmell and Wahl, 1970).

**Binaural Interaction**

Figure 7 illustrates that Internet respondents were almost twice as likely to include binaural interaction tests in their battery than Maryland respondents. The RASP (Ivey, 1969; Willford, 1977, 1978) and masking level difference (MLD) (e.g., Hirsh, 1948; Licklider 1948) were the most commonly reported tests of binaural interaction by Internet respondents; however, these tests were reported less than 25 percent of the time. Less frequently listed tests
Physiologic Tests

The consensus statement recommended a minimal AP test battery that included both behavioral and physiologic assessments designed to target both the peripheral and central auditory systems.

Figure 8 illustrates that the most common physiologic test administered as part of the standard AP battery was immittance (79% Maryland, 92% Internet), with 71 percent (Maryland) and 76 percent (Internet) reporting the ART test, specifically, as part of the standard battery. Less than 40 percent of respondents indicated that they conduct acoustic reflex decay (ARD) testing. Less than 50 percent of respondents reported including OAEs as part of the standard AP battery (46% Maryland, 44% Internet), but most Internet respondents included OAEs as part of either their standard or their extended test battery. “Other” responses from the survey included the use of ipsilateral and contralateral suppression of OAEs as part of the AP battery.

Electrophysiologic tests were reported as part of the standard AP battery for less than 15 percent of respondents; however, many of the electrophysiologic tests were reported as part of the extended test battery. The ABR was the most frequently reported electrophysiologic test, with 64 percent (Internet) and 46 percent (Maryland) reporting that ABR was part of either the standard or the extended test battery. AMLR was rarely part of the standard test battery (4% Internet, 7% Maryland) but was more frequently included as part of the extended test battery (36% Internet, 18% Maryland), especially for Internet respondents. Fewer than 35 percent of respondents included any cortical event-related potentials (ALR, MMN, P300), even in
Auditory Attention

Based on this survey, 40 percent of Internet and 32 percent of Maryland respondents conduct an attention assessment. Examination of Figure 9 indicates that the most commonly reported attention assessment for both groups was the Auditory Continuous Performance Test (ACPT) by Keith (1994b). This test was reported for 40 percent of the Internet group and 18 percent of the Maryland group.

Other tests of attention reported less than 15 percent of the time include the Conners’ Continuous Performance Test (Conners, 1994), Vigil Continuous Performance Test (Vigil, 1996), and Selective Auditory Attention Test (Cherry, 1980). One “other” response included “a test of Executive Function to rule out [attention-deficit hyperactivity disorder] ADHD.” Executive function is “a component of metacognition that refers to a set of general control processes that ensure that an individual’s behavior is adaptive, consistent with some goal and beneficial to the individual” (Chermak and Musiek, 1997, p. 16-17). However, the respondent did not include a description of the procedures used to assess executive function.

Classroom Observation

Less than one-third of the respondents indicated that they routinely performed a classroom observation/assessment. Reported observation protocol included site-specific checklists; observations by a teacher, social worker, or counselor; and forms from the Educational Audiology Handbook by DeConde Johnson and colleagues (2001).

Memory

Auditory memory was assessed by just over 20 percent of each group. Figure 10 indicates that the most commonly reported test for auditory memory was the Test of Auditory Perceptual Skills (TAPS-R) (Gardner, 1997), with 21 percent of Maryland respondents and 16 percent of Internet respondents listing this test. Less than 5 percent of respondents reported using the Denver Auditory Phoneme Sequencing Test (DAPST) (Aten, 1979). “Other” reported tests for assessing memory included the Token Test for Children (TTFC) (DiSimoni, 1978), Detroit Test of Learning Aptitude (Hammill, 1998), “memory for sentences from several sources,” and “digit span” (presumably, the Visual Aural Digit Span test by Koppitz, 1975).

Speech-Language and Psychoeducational Testing

Thirty-two percent (Internet) and 19 percent (Maryland) of the respondents reported incorporating speech-language/psychoeducational tests as part of their assessment protocol. Of the respondents conducting speech-language/psychoeducational tests, 50 percent (Internet) and 20 percent (Maryland) were dually certified in audiology and speech-language pathology. Figure 11 illustrates that the tests reported most frequently by the Internet group included the...
Lindamood Auditory Conceptualization Test (Lindamood and Lindamood, 1979), by 28 percent of Internet respondents, and the Clinical Evaluation of Language Fundamentals (Semel et al, 1995), by 20 percent of Internet respondents. Maryland respondents most frequently reported the TAPS (18%), which was also reported by 16 percent of the Internet group. Other tests reported by less than 20 percent of respondents included the TTFC, Phonological Awareness Test (Robertson and Salter, 1997), Woodcock-Johnson Psychoeducational Battery-Revised (Woodcock and Johnson, 1989), Test for Auditory Comprehension of Language-3 (Carroll-Woolfolk, 1999b), and Auditory Discrimination Test (Reynolds, 1994). “Other” reported tests included the Comprehensive Test of Phonological Processing (Wagner et al, 1999), Photo Articulation Test (Lippke et al, 1997), Peabody Picture Vocabulary Test-Revised (Dunn and Dunn, 1981), Expressive One-Word Picture Vocabulary Test (Brownell, 1990), Test of Phonological Awareness (Torgesen and Bryant, 1994), Phonographic pretest (McGuinness et al, 1996), Oral and Written Language Scales (Carroll-Woolfolk, 1996), Comprehensive Assessment of Spoken Language (Carroll-Woolfolk, 1999a), Slosson Oral Reading Test (Nicholson, 1990), Gray Oral Reading Test (Wiederholt and Bryant, 2001), Test of Word Finding (German, 1991), and the Test of Written Language (Hammill and Larson, 1996).

Other Professional Evaluations as Part of the AP Protocol

Figure 12 indicates that the most common referral/team assessments reported as part of the standard AP protocol or extended battery were a speech-language evaluation (92% Internet, 75% Maryland), an educational evaluation (76% Internet, 72% Maryland), and a psychological evaluation (76% Internet, 72% Maryland). Approximately 40 percent of both groups also reported an educational and psychological assessment as part of the standard protocol for AP assessment. Evaluation by other professionals (otolaryngologist, neurologist) was rarely reported as part of the standard battery but was reported on an “as needed” basis by more than 50 percent of respondents. “Other” responses included assessments by a counselor, developmental pediatrician, and neuropsychologist and input from a parent interview.

Test Battery

Each survey was examined to determine if the individual respondent followed the minimum behavioral and physiologic test battery suggested by the APD consensus statement. Specifically, each response was examined to determine if the respondent included pure-tone audiometry, a performance-intensity function, a dichotic task, duration pattern sequence testing, temporal gap detection (either “gap detection” generically or the AFT), immittance audiometry, OAEs, ABR, and AMLR tests.

None of the respondents listed all of the tests suggested by the APD consensus statement minimum test protocol. All of the respondents reported using dichotic tests, pure-tone audiometry, and some portion of the immittance battery, and over 60 percent of the respondents reported temporal processing tests; however, less than 50 percent reported conducting a DPT or a gap detection test, with the Internet group more likely to conduct these tests. Only 24 percent (Internet) and 12 percent (Maryland) of the respondents indicated that a performance-intensity function was required. In addition, less than 30 percent of respondents indicated that they administered the SSI-ICM or PSI, two tests that can be administered in a performance-intensity format for synthetic sentences (SSI-ICM), meaningful sentences (PSI), or words (PSI).

DISCUSSION

Questionnaire

Questionnaires are given to parents, caregivers, and teachers to assess observed behaviors and competencies in children suspected of APD. The CHAPS, the Fisher, and the SIFTER
provide information regarding the specific type of functional difficulties the child is experiencing. In addition, responses can be tallied to indicate if the child is below normal or at risk academically. Most of the respondents from both the Internet and Maryland groups reported using questionnaires as part of the AP battery.

The most commonly reported questionnaire, the CHAPS, was created to "systematically collect and quantify the observed listening behaviors of children... [and] can be useful in prescribing therapeutic intervention and/or the need for classroom accommodations" by having an observer (such as the child’s teacher) answer questions across six conditions, including quiet, ideal, multiple inputs, noise, auditory memory/sequencing, and auditory attention span (Smoski et al, 1998). The CHAPS manual includes the results of a study of 64 children with APD (Smoski et al, 1992), test–retest reliability data for 20 of these children, and normative data based on 20 non-APD children of similar age and background. A reported case study using the CHAPS (Garstecki et al, 1990) showed an improvement in CHAPS score and in CAP diagnostic tests following auditory processing therapy, suggesting that the CHAPS may be a useful tool as part of the diagnosis and management protocol for children with APD.

The SIFTER, the second most commonly reported test from the current study, is broken down into five categories: academics, attention, communication, class participation, and school behavior. Normative data provided with the SIFTER include a much larger sample size (530 impaired, 50 typical). Although it was the second most commonly reported test in the current study, a limitation of this test is that it was designed for and tested on children with APD. Therefore, the Fisher includes a broad range of general items such as "has a history of hearing loss" and "has difficulty with phonics"; however, the items are not classified into specific categories, which makes it somewhat more limited for use in the AP battery than the CHAPS and SIFTER.

**Basic Audiologic Evaluation**

The current study indicated that 100 percent of respondents required a pure-tone test and tympanometry and close to 100 percent required a WRS prior to AP testing; however, less than 25 percent were conducting performance-intensity functions. This is consistent with trends in audiological testing reported by Martin et al (1998), who found that PIPB testing decreased significantly from approximately 72 percent (1989) to 44 percent (1992) to 26 percent (1997). However, in the Martin et al study, PIPB was presumably used for retrocochlear diagnosis rather than for AP assessment. Performance-intensity functions in the AP battery can also be useful for examining word recognition performance between ears, across presentation level, and with various stimuli for children.

AP is generally assessed in children with normal peripheral hearing sensitivity. According to ASHA (1996), there is little systematic research on the effect of peripheral hearing loss on AP tests, and few tests are available to separate the effects of central versus peripheral pathology. ASHA (1996) suggested that AP testing could be administered with a peripheral hearing loss if the results are viewed with caution, tests are selected that are minimally impacted by peripheral hearing loss (such as dichotic digits, CS, MLR, and P300), and the effects of the peripheral hearing loss are taken into account in the interpretation of the AP tests. The importance of assessing peripheral hearing sensitivity was also emphasized by the APD consensus statement, which suggested that a minimal test battery include pure-tone audiometry, performance-intensity functions for word recognition, and immittance audiometry. With the exception of performance-intensity functions, respondents from the current study were following suggested guidelines for assessing peripheral hearing sensitivity prior to AP assessment.

**Monaural Low-Redundancy Speech Tests**

Monaural low-redundancy speech tests deliver auditory stimuli, to one ear at a time, that have been altered with techniques such as filtering, time compression, and background noise to reduce the inherent redundancy in the speech signal to make it more difficult for a disordered central auditory nervous system to decode the signal.

The most popular tests in this category were the FW and AFG subtests of the SCAN, SCAN-A, and SCAN-C. Although other subtests (CW, CS) are listed under the dichotic portion of this article, the general test will be described here.

The SCAN was originally marketed as an AP screening battery that could be administered via standard cassette player in a quiet room or via clinical audiometer in a sound booth; how-
ever, Emerson et al (1997) found that SCAN scores obtained in a quiet school setting were markedly different from scores obtained in a sound booth. The SCAN has been criticized as an AP assessment tool because of the absence of a temporal processing measure (Bellis, 1996), limited normative data sample for 3 to 4 year olds (Chermak and Musiek, 1997), and questionable reliability (Amos and Humes, 1998).

The SCAN-A was developed to extend this battery of AP tests to adolescents and to adults. In addition to the three-subtest format used in the SCAN (FW, AFG, and CW), it includes a fourth subtest of CS. The word “screening” does not appear in the title of the SCAN-A. It is simply “A Test for Auditory Processing Disorders in Adolescents and Adults.”

The SCAN-C is a revision of the SCAN and is designed for children 5 years of age to 11 years, 11 months of age. Significant changes from the original SCAN include the use of the four-subtest format (FW, AFG, CW, CS) similar to the SCAN-A; a change in the title, omitting the term “screening” and calling the instrument “Test for Auditory Processing Disorders in Children-Revised”; providing the test on compact disc rather than cassette; improving the test instructions to the child; and eliminating normative data for 3- and 4-year-old children.

The use of the SCAN-C, SCAN-A, and SCAN as part of a diagnostic battery remains the subject of debate, with some asserting that it is a screening test (Medwetsky, 1994; Hall, 1999) and clinicians relying on it as part of their test battery based on findings from the current study and the results of the Martin et al (1998) and Chermak et al (1998) studies.

**Dichotic Listening**

Dichotic listening tasks involve presenting two different stimuli, one to each ear, simultaneously. The listener is required to repeat or identify stimuli from one or both ears. The SSW, SCAN-C, and SCAN-A (CW and CS subtests) were three of the most popular tests according to this survey. An advantage to using the SSW for assessment of AP is that studies of the SSW are prevalent in the professional literature for children (Myrick, 1965; Stubblefield and Young, 1975; White, 1977; Johnson and Sherman, 1979; Johnson et al, 1981; Berrick et al, 1984; Windham, 1985; Windham et al, 1986) and adults (Katz et al, 1963; Arnst and Katz, 1982). Similarly, the SCAN-C and SCAN-A provide detailed information regarding administration and interpretation for adults and children and are prevalent in the literature (Keith, 1994a, 2000).

Dichotic digits (Musiek, 1983) were also frequently reported by the Internet group but rarely by the Maryland group. Dichotic digits tests are easy to obtain but come with sparse documentation for test administration and interpretation. Reports of performance on dichotic digit tests for adults and children are available in the literature (Musiek and Geurkink, 1980; Musiek, 1983; Musiek and Pinheiro, 1985; Musiek et al, 1991; Jirsa, 2001). Clinicians should be aware that normative data available in the professional literature may be specific to a particular recording and that clinicians should collect their own normative data (Musiek, personal communication, July 17, 2001).

**Temporal Processing**

The consensus statement stressed the importance of temporal processing tests by recommending that the minimal battery include three tests specifically designed to target temporal processing: duration patterns, frequency patterns, and gap detection. More than 60 percent of all respondents indicated that they conduct frequency pattern tests, but few indicated the use of a duration pattern test or a test of gap detection.

Research in auditory perception has indicated some basic characteristics of temporal processing ability in humans, including the following: sounds separated by an interval less than 2 msec are perceptually fused by the listener; as the interval between sounds increases beyond about 2 msec, a listener can identify the presence of the interval, and this interval has to be 15 to 20 msec for a listener to accurately report which of the sounds occurred first (Hirsh, 1959). Accuracy of detecting order of presentation is crucial in speech discrimination. A linguistic example of the importance of accuracy in ordering of information includes perceiving the “t” prior to the “s” for accurate perception of the word “fits” rather than the word “fist.” Hirsh (1959) asserted that the large temporal interval required for accurate identification of temporal order suggested that anatomic and physiologic systems beyond the peripheral auditory system must be involved in judgment of these acoustic events. Every central auditory nucleus within the central nervous system up to and including the auditory cortex has been found to be sensitive to the effects of time (Pinheiro and Musiek,
The ability of humans to speak and understand language is dependent on the sensitivity of the central auditory nervous system to process sound sequences, and difficulty with temporal processing of auditory signals has been associated with language impairment (Tallal 1980; Tallal et al, 1993; Phillips, 1999; Chestnik and Jerger, 2000).

Temporal ordering/sequencing tests involve a behavioral ordering (e.g., verbal labeling, humming) of acoustic stimuli (e.g., noise, tones, clicks, speech) that vary in intensity, frequency, and/or duration (Pinheiro and Musiek, 1985). Commercially available tests include both frequency pattern and duration pattern sequences. Although both frequency and duration pattern sequence tests yield bilateral deficits in response to unilateral central lesions, performance for these two tests has been shown to differ markedly for subjects with central lesions and therefore appears to involve different auditory processes (Musiek et al, 1990).

Frequency pattern tests were reported more than any other temporal processing test. These tests are commercially available from three sources: Auditec, Audiology Illustrated, and the Veterans' Administration. The PPS test, available from Auditec, has child (6–9 years) and adult (age 9 to adult) versions, with identical scoring sheets. The listener is required to hum or verbally label tones from a three-tone series as “low” or “high.” The children’s version by Auditec includes increased tone duration, interburst interval, and interpattern interval compared with the adult version. The scoring information provided with the Auditec child version includes means and ranges for children in three age categories with no other references or other normative data. The adult version from Auditec includes means and ranges for 9 to 10 year olds and for adults with no additional normative data or references. The Audiology Illustrated version (Frequency Pattern Test) includes a one-page instruction sheet listing normal scores for each year from 8 to 11 and 12 to adult norms. In addition, two references are included (Musiek and Pinheiro, 1987; Musiek, 1994). The Veterans’ Administration (1992) DPT is not accompanied by supporting literature. Normative data can be found in the literature for adults (Musiek, 1994).

The Audiology Illustrated frequency pattern test instructions, unlike the Auditec test instructions, do not include reversals (e.g., low high low for high low high) as normal. Musiek (1994) pointed out that although a certain number of reversals are seen for normal-hearing subjects, subjects with brain abnormalities have a large number of reversals, and they should be considered incorrect for frequency pattern tests. Normative data for these tests do not separate “hummed” and “verbal” response norms. This may be useful information for test distributors to provide considering the different performances seen for children with APD for hummed versus verbal response (Jirsa, 2001). Musiek and colleagues (1980) found that split-brain patients could not accurately report a frequency pattern verbally; however, hummed responses were normal or near normal for the subjects they studied. They suggested that these findings indicate that both hemispheres and the corpus callosum were required to decode a frequency pattern and report the results verbally, presumably the right for decoding spectral content and the left for speech-language and temporal ordering.

DPTs are also available from Audiology Illustrated, Auditec, and the Veterans’ Administration. This test requires the listener to identify each element in a three-tone series as “long” or “short.” The Audiology Illustrated version comes with one page of instructions and background information. Specifically, it states that 70 percent and above is normal for adults, and there are no child normative values. References are included (Musiek et al, 1990; Musiek, 1994), and it is recommended that clinicians establish their own normative values. The Duration Pattern Sequence Test (Auditec) comes with a one-page instruction sheet and states that scores below 67 percent should be considered abnormal. One reference is provided (Musiek et al, 1990), and the age range for this test is not given. Normative data for adults on the Veterans’ Administration DPT are available from Musiek (1994).

Additional information regarding frequency and DPTs is available in the literature for children and adults (e.g., Pinheiro and Ptacek, 1971; Ptacek and Pinheiro, 1971; Musiek and Geurkink, 1980; Pinheiro and Musiek, 1985; Musiek and Pinheiro, 1987; Phillips, 1999; Jirsa, 2001). At present, further study of duration pattern testing in children is needed.

Gap detection tests were reported infrequently in the current study. A gap detection task involves identifying the presence of a brief silent period between two bursts of sound. Listeners may be required to identify which of two sounds contains a gap or to indicate if a gap was present in a single stimulus. The smallest discernible silent period is called the gap detection threshold. Gap detection threshold varies.
based on test paradigm, with the lowest gap detection thresholds associated with broadband signals. High-frequency narrow-band signals yield lower gap detection thresholds than low-frequency narrow-band signals, and within-channel paradigms are associated with smaller gap detection thresholds than between-channel designs (Phillips, 1999). According to Jerger and Musiek (2000), the recommended gap detection test is one in which a "short silent gap is inserted in a burst of broad-band noise." This type of test, however, is not commercially available at present (Musiek, personal communication, July 17, 2001).

Of the less than 30 percent of respondents who indicated that they conduct gap detection testing, the most frequently reported test was the AFT-R. The AFT-R does not meet the exact description of a gap detection test specified by Jerger and Musiek (2000); however, it requires listeners to identify the presence of a silent gap (interpulse interval) occurring between two tone pulses and thus would fall into the general category of gap detection tasks. The listener must identify if he/she hears one tone or two in a series of ascending and descending interpulse interval trials. An advantage of this test is that it is commercially available and can be administered to adults and children as young as 3 years, assuming that the listener understands the difference between "one" and "two." A disadvantage of this test is the testing paradigm, which includes predictable ascending and descending interpulse interval trials of 0 to 40 msec (40–300 msec for the expanded test). A modification of the AFT-R, the Random Gap Detection Test, was recently developed by Keith. This modification uses random interpulse intervals rather than a series of ascending and descending interpulse interval trials.

**Binaural Interaction**

Specific tests of binaural interaction, including tests that require a listener to combine separate but simultaneously presented information to each ear (binaural fusion, RASP) and tests that determine auditory threshold for binaurally presented stimuli in background noise before and after the phase shift of the stimulus or noise (MLD), were reported by less than 25 percent of respondents. In addition, localization and lateralization tests were infrequently reported in the current study. This is not surprising, considering that commercially available tests of localization/lateralization are not available at this time. However, there are published methodologies for testing (Cranford et al., 1990; Besing and Koehnke, 1995; Abouchacra et al., 1998), and a virtual localization test that can be administered via compact disc, currently still in laboratory trials, may be released for clinical use shortly (Besing, personal communication, July 24, 2001).

**Physiologic Tests**

Many of the respondents indicated that they include ART tests as part of their AP battery. Presumably, audiologists are attempting to eliminate the possibility of peripheral, cranial nerve VIII, or low brainstem pathology as a cause of AP difficulties prior to examination of more central involvement. This test can be useful for AP testing, as shown by a case study reported by Lenhardt (1981) of a child with APD caused by a low brainstem dysfunction that was investigated only because of absent acoustic reflexes during an audiological examination.

Few respondents indicated that they conduct ARD testing. This is not surprising, considering the limited additional value of ARD testing for AP diagnosis compared with the possibility of inducing tinnitus and hearing threshold shift with high-intensity stimuli during this test (Hunter et al., 1999).

OAE testing was reported by just over 40 percent of the respondents from each group as part of the standard battery but by almost 80 percent of the Internet group as part of the standard or extended battery. OAEs are specified by the consensus statement as "useful in ruling out inner ear disorders" (p. 471). Presumably, OAEs as part of the AP battery are used to further investigate the peripheral auditory system including comparison of OAE results with ABR results to rule out auditory neuropathy (Hood, 1998). Surprisingly, only one respondent indicated the use of an OAE suppression test using ipsilateral and contralateral noise. This test has been shown to identify problems with the efferent auditory system (Hall, 2000).

Although less than 15 percent of respondents indicated using the ABR as part of their standard AP test battery, 64 percent (Internet) and 46 percent (Maryland) reported using it as part of either their standard or their extended test battery. These results are similar to the findings of Chermak et al (1998), who found 59 percent of respondents administered ABR with a rating from 4 to 6 (0 = never, 1 = least, 6 = most used), with only a few respondents reporting
the use of any other electrophysiologic test (MLR and P300). Later evoked potentials were reported infrequently in the current study, although much more frequently for the Internet group compared with the Maryland group. Although the Maryland group represents an attempt to sample an entire population, the Internet group most likely represents an unusually technologically savvy group of audiologists based on the way the survey was distributed (via Internet forum and the need to open and save the attached file, complete the survey, and attach the survey to a return e-mail message).

ABR has been established as an efficient instrument for assessing the vestibulocochlear nerve and brain stem; however, its usefulness for upper brainstem and cortical assessment is limited (Jirsa and Clontz, 1990). Other electrophysiologic tests, which extend beyond the latency of ABR, show promise in the AP diagnostic process (Kurtzberg, 1989), and their underuse may be based on lack of familiarity with longer latency test paradigms and the applicability of test results to APD diagnosis and management.

Studies of later potentials have shown changes in these potentials following AP intervention and have found differences between children with APD and non-APD children. For example, a study by Jirsa and Clontz (1990) found significantly longer latency for late evoked potentials in children with APD compared with a normal control group. Jirsa (1992) compared normal children with children diagnosed with APD and found a significant difference between the amplitude and latency of the P3 between the normal controls and the children with APD. Half of the APD group participated in a 14-week program of intense listening exercises for auditory memory, language comprehension, auditory discrimination, attention, and interpretation of auditory directions. Following the treatment, there was a significant change in the P3 amplitude and latency for the treatment group compared with the APD control group. Kraus and McGee (1994) suggested that the diagnostic implications of the MMN include providing an objective measure of auditory discrimination as part of the AP battery. They presented a series of case studies in which the MMN was useful in the diagnostic battery to detect deficits in cortical level processing of auditory discrimination tasks.

Attention

ADHD is diagnosed by a psychiatrist or psychologist based on comparing characteristics displayed by the child with published criteria (e.g., Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; American Psychiatric Association, 1994). The child may fall into one of three subtypes, including the predominantly inattentive type, predominantly hyperactive-impulsive type, or a combination of the two. It is important for audiologists involved in the diagnosis of APD to consider the possibility of ADHD during AP assessment as these two disorders may be comorbid or may be difficult to diagnose differentially (Moss and Sheiffele, 1994).

According to ASHA (1996), “For some persons, APD is presumed to result from the dysfunction of processes and mechanisms dedicated to audition; for others, APD may stem from some more general dysfunction, such as an attention deficit or neural timing deficit, that affects performance across modalities. It is also possible for APD to reflect coexisting dysfunctions of both sorts” (p. 41). Children diagnosed with ADHD and APD may display overlapping behaviors, including difficulty following directions, asking for directions to be repeated, performing inconsistently in school, and having difficulty listening, although peripheral hearing sensitivity is normal. Despite the overlap in behavioral profiles, Chermak et al. (1999) argued that APD and ADHD are distinct clinical entities that may sometimes coexist based on neuroanatomic causes and the possibility that auditory perceptual deficits may trigger attention deficits.

The most commonly reported test of auditory attention for the 30 to 40 percent of respondents who conduct attention tests was the ACPT. The ACPT, reported by 40 percent of Internet respondents and 18 percent of Maryland respondents, is an auditory vigilance task requiring the child to listen to a list of words and raise his/her thumb in response to every presentation of the word “dog.” The validity of the ACPT has been examined by comparing differences in performance between children with ADHD with and without medication (Keith and Engineer, 1991; Tillery et al, 2000) and comparing differences in performance between children with ADHD and children without ADHD (Keith, 1994b; Riccio et al, 1996a).

Keith and Engineer (1991) found a significant improvement in ACPT performance when children with ADHD were medicated with
methylphenidate compared with the nonmedicated condition; however, they also found improvements in performance on the SCAN and Token Tests for children between the two conditions. Their study failed to control for order effects in that only 1 of their 20 subjects was tested in the medicated condition first. A later study that used a counterbalanced design to control for order effects was conducted by Tillery et al (2000). They found that scores on three AP tests, the SSW, phonemic synthesis (Katz and Harmon, 1982), and SIN (Mueller et al, 1987), were not significantly different when children with ADHD and APD were medicated with methylphenidate (Ritalin) compared with the nonmedication condition; however, ACPT scores were significantly different between groups, indicating that the medication affected auditory attention but not auditory processing. Riccio et al (1996a) found that children with APD scored higher than children diagnosed with APD plus ADHD, but the difference did not reach significance for this sample. This is in contrast to an earlier study that showed significant differences between groups (Keith, 1994b). The Riccio et al (1996a) study diagnosed APD based only on the SSW test. This may be a critical flaw since scores on the SSW may (Gascon et al, 1986; Cook et al, 1993) or may not (Riccio et al, 1996b) be affected by attention.

The less frequently reported Vigil and Conners tests are computer-based tests that include nonverbal stimuli (Vigil includes auditory and visual). With current emphasis on the importance of multimodality testing (Hall, 1999; Jerger and Musiek, 2000), these two tests may warrant further study for use with AP testing.

Multidisciplinary Assessment

The best practice for assessment and management of APD is a team assessment or collaborative approach (ASHA, 1996). The APD consensus statement recommended that the team include an audiologist and speech-language pathologist at a minimum. The responses to this survey indicated that a majority of audiologists include professional assessments from other disciplines as part of their assessment protocol for AP. Although it may not be possible for an audiologist to perform an on-site observation, the use of questionnaires (previously discussed), reports from school officials, or communication with the child's teacher regarding classroom acoustics and format were reported and can be used in developing recommendations for children with APD. Auditory memory tests are infrequently administered by audiologists, presumably because these tests are commonly administered by speech-language pathologists and psychologists. The most common referral in either the standard or extended battery from 92 percent of the Internet group and 73 percent of the Maryland group was for a speech-language evaluation followed by the psychological (76% Internet, 72% Maryland) and educational evaluations (78% Internet, 72% Maryland), indicating the importance placed on the need for an interdisciplinary assessment team in the assessment and management of children with difficulties associated with AP.

Test Battery

The results of the survey indicated that none of the respondents completed all of the tests recommended by the consensus statement. There are a number of possible reasons why clinicians are not following the APD consensus statement protocol, including the following:

1. Some tests are not commercially available (e.g., gap detection tests using white noise, localization). Protocols exist in the published literature but require clinicians to develop test materials.
2. Although many AP tests are easily obtainable, many come with little supporting documentation for administration and interpretation. Normative data may need to be developed by individual testing facilities to account for differences in regional dialect, or normative data may be specific to a particular version of the test (Musiek, personal communication, July 17, 2001). Distributors of AP tests often include a disclaimer with their tests, indicating that administration and scoring information are limited (or not provided at all) and that purchasers of AP tests should obtain further information from the literature and/or seminars (e.g., Auditec, 1998).

Although it is true that clinicians who administer AP tests must have both theoretical and practical knowledge of AP (ASHA, 1996), it is not surprising that one of the most commonly reported AP tests from this and other studies (e.g., Chermak et al, 1998) is the SCAN (or SCAN-A or SCAN-C)—a professionally packaged and marketed test including instructions for administration and scoring.
3. Another potential reason for the differences in test protocol is the heterogeneity of the population of children with APD. A diverse and flexible test battery, rather than the same battery for every child, is essential in appropriate assessment and management of these children (Pinheiro and Musiek, 1985; Bellis and Ferre, 1999). Traditional AP testing for adults followed the medical model of diagnosis to identify pathology. This is evidenced by examining some of the traditional AP tests, such as the SSW, which includes extensive documentation for localization of site of lesion. Many of the reported studies of AP test sensitivity and specificity compare results to a radiologically or surgically diagnosed brainstem and/or cortical pathology (e.g., Pinheiro, 1976; Hurley and Musiek, 1997; Musiek et al, 1980; Musiek and Pinheiro, 1987). Although APD has been attributed to neurophysiologic disorder (such as polymicrogyri and heterotopias), neuro-maturational differences, neurologic pathology, and trauma (Chermak and Musiek, 1997), many causes of functional deficits cannot be attributed to a specific pathology. The focus for AP assessment with children should be to determine if the functional deficits in listening and learning experienced by the child can be attributed to the auditory system and, if so, how these deficits can be remediated or managed. The current battery of tests for most clinicians includes many tests of peripheral and lower brainstem function, including immittance, OAE, ABR, and PIPB functions. In contrast, some of the most exciting research over the past few decades has focused on cortical processing; however, these tests are rarely reported as part of the AP battery.

4. Electrophysiologic tests may not be available at some audioligic facilities that conduct AP tests. For example, in a public school system, obtaining electrophysiologic equipment, or referral to an outside agency for expensive electrophysiologic testing, may not be considered warranted by the ARD team, especially considering that APD is not classified as a disability under the Individuals with Disabilities Education Act as of the writing of this article. Perhaps more research on the relationship between electrophysiologic diagnosis and management outcomes and greater advocacy within the school system by audiologists performing AP testing may lead to the evolution of AP testing toward more electrophysiologic testing, including later cortical event-related potentials.

5. Another potential reason for clinicians not following the APD consensus statement protocol is the audiologist's prerogative to determine the test protocol that will best benefit the child based on a review of the literature and clinical experience. Jerger (1998) indicated in an editorial that he became "extremely depressed" by the Martin et al (1998) findings of current audiologic practices. Miller (1998) responded to Jerger's editorial with the following statement: "There is a considerable time gap between publication of new data and their acceptance on the clinical level. Perhaps this is not 'all bad' since it gives us an opportunity to evaluate what is new (which is not always good) and to preserve what is old (not always bad)'" (p. 311). The autonomy of audiologists relies on our ability to independently consider the merits of our test protocol. Some audiologists may argue that they do not agree with the protocol outlined by the Jerger and Musiek (2000), whereas others may counter that the use of tests that are convenient, but do not follow best practices, is not an example of professional autonomy but professional inertia (Jerger, 1998).

6. According to Sykes et al (1997), 88 percent of on-campus clinics in graduate audiology programs offer APD evaluations; however, Chermak et al (1998) suggested that university training programs do not adequately prepare students to assess the central auditory nervous system. Audiologists may not be using best-practice models of assessment because of poor training during their graduate education program.

SUMMARY

1. The typical AP test battery consists of dichotic speech tests, monaural low-redundancy speech tests, and questionnaires. All audiologists require a basic audiology evaluation prior to AP testing, and most include information from other professional evaluations (via referral or on-site team) as part of the APD diagnostic protocol. More than half of the audiologists include temporal processing tests, and many include ABR as part of their standard and/or extended test battery, but few include longer latency potentials.
2. None of the audiologists in this survey reported using a protocol that met APD consensus statement guidelines for minimum APD testing. The most often omitted tests included AMLR, duration pattern, performance-intensity function, and gap detection testing.

3. Tests that are commercially packaged and accompanied by detailed instructions and interpretation guidelines (including normative data) such as the SCAN, SCAN-A, SCAN-C, and ACPT are often the most widely clinically used tests of APD in each category.

4. Many tests are available from commercial and research facilities or from individual researchers; however, the quality of supporting materials varies, and some tests lack normative and reliability data, especially for children (McFarland and Cacace, 1995). In some cases, published studies are applicable only to specific versions of the test, adult listeners, or subjects with a specific pathology. Individual testing facilities may need to develop their own normative data and, in some cases, their own tests to conduct the entire APD battery.

Acknowledgment. The author would like to thank Dr. Barbara Laufer and Dr. Peggy Oates for their review of the manuscript and Patricia Lucas for her assistance during the development of the survey.

REFERENCES


Carrow-Woolfolk E. (1999b). *Test for Auditory Comprehension of Language-3 (TACL-3)*. Austin, TX: Pro-Ed.


processing disorder and attention deficit disorder. J Psychiatr Neurosci 18:130–137.


Hammill DD, Larson SC. (1996). Test of Written Language (TOWL-3). Austin, TX: Pro-Ed.


**APPENDIX A**

Survey of Audiologists' Central Auditory Processing (Auditory Processing\(^1\)) Assessment Battery for Children (Preschool to Age 18)

1. Do you conduct auditory processing assessments? Yes No
   
   If no, please stop here and return the survey. Thank you!

2. Please check your area(s) of certification and/or licensure.
   
   —Audiology
   —Speech-language pathology
   —Psychology
   —Education
   —Other. Please specify:

3. Do you usually have a parent, teacher, and/or client (if age appropriate) complete a questionnaire for AP evaluations? Yes No
   
   If yes, which ones?

\(^{1}\) "AP" seems to be more appropriate than "CAP" based on "goals of maintaining operational definitions, avoiding the imputation of anatomic loci, and emphasizing the interactions of disorders" (Jerger and Musiek, 2000). However, clinical use of "CAP" is still common. For this survey, we did not wish to confuse clinicians who use the traditional "CAP" label.

4. Do you administer monaural low-redundancy speech tests? Yes No
   
   Please check all you commonly use as part of your test battery.
   
   —Time-compressed speech test, NU-6
   —Time-compressed speech test plus reverberation, NU-6
   —Ivey filtered speech test (Willeford Central Test Battery)
   —Speech in noise word recognition test
   —Discrimination of Phonetically Balanced Kindergarten in Noise
   —Synthetic Sentence Identification test with Ipsilateral Competing Message
   —SCAN-C, Filtered Words
   —SCAN-A, Filtered Words
   —SCAN-C, Auditory Figure Ground
   —SCAN-A, Auditory Figure Ground
   —SCAN, Filtered Words
   —SCAN, Auditory Figure Ground
   —Low-pass filtered speech test
   —Pediatric Speech Intelligibility test
   —Other. Please specify:

5. Do you assess dichotic listening? Yes No
   
   Please check all you commonly use as part of your test battery.
   
   —Dichotic Digits test
   —Staggered Spondaic Words test
   —Competing Sentences test
   —Dichotic Consonant Vowel test
   —Synthetic Sentence Identification test with Contralateral Competing Message
   —Dichotic Sentence Identification
   —SCAN-C, Competing Words
   —SCAN-A, Competing Words
   —SCAN-C, Competing Sentences
   —SCAN-A, Competing Sentences
   —SCAN, Competing Words
   —Dichotic Rhyme test
   —Other. Please specify:
8. Do you administer electrophysiologic tests as part of your AP battery? Yes  No
Please check tests used as part of the standard test battery and as part of the extended test battery (based on individual client needs).

<table>
<thead>
<tr>
<th>Electrophysiologic Tests</th>
<th>Part of Standard Test Battery</th>
<th>As Needed, Based on Individual Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory brainstem response</td>
<td></td>
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<tr>
<td>Otoacoustic emissions</td>
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<td></td>
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<tr>
<td>Acoustic reflex threshold</td>
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<tr>
<td>Acoustic reflex decay</td>
<td></td>
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<tr>
<td>Auditory middle latency response</td>
<td></td>
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<tr>
<td>Auditory late response</td>
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<td></td>
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<tr>
<td>Mismatched negativity response</td>
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<td></td>
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<tr>
<td>P300</td>
<td></td>
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<tr>
<td>Immittance audiometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other. Please specify:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you assess localization and/or lateralization? Yes No
How? __________________________________________

9. Do you assess auditory attention? Yes No
Please check all you use as part of your test battery.
   ______ Auditory Continuous Performance Test
   ______ Conners' Continuous Performance Test
   ______ Vigil Continuous Performance Test
   ______ Selective Auditory Attention Test
   ______ Other. Please specify:

10. Do you routinely perform a classroom observation/assessment? Yes No
If yes, do you fill out an evaluation as part of the observation/assessment? Yes No
What type of evaluation do you complete? __________________________________________

11. Do you assess memory? Yes No
Please check all you use as part of your test battery.
   ______ Test of Auditory-Perceptual Skills-Revised
   ______ Auditory Number Memory
   ______ Auditory Number-Reverse Memory

   Other. Please specify: __________________________________________
Auditory Sentence Memory
Auditory Word Memory
Goldman-Fristoe-Woodcock Auditory Memory Test
Recognition Memory
Memory for Content
Memory for Sequence
Denver Auditory Phoneme Sequencing
Auditory Sequential Memory Test
Other. Please specify:

12. Do you require a basic audiologic assessment prior to AP testing? Yes No
Please check all you require prior to (or during) AP assessment.
__Otoscopic evaluation
__Pure-tone air-conducted/bone-conducted evaluation
_Speech recognition threshold
_Word recognition
_Sentence recognition
_Nonsense syllable recognition
_Performance-intensity function
_Tympanometry
_Other. Please specify:

13. Do you administer speech-language and/or psychoeducational tests as part of your AP test battery? Yes No
Please check all you use as part of your test battery.
__Test of Auditory Perceptual Skills
__Auditory Interpretation of Directions
__Auditory Word Discrimination
__Auditory Processing
__Goldman-Fristoe-Woodcock Auditory Skills Battery
_Quiet Subtest
_Noise Subtest
__Lindamood Auditory Conceptualization Test
__Isolated Sounds in Sequence
__Sounds within a Syllable Pattern
__Auditory Discrimination Test
__Test for Auditory Comprehension of Language-3
_Vocabulary
_Grammatical Morphemes
_Elaborated Phrases and Sentences
_Token Test for Children
_Part I—two critical elements
_Part II—four critical elements
_Part III—three critical elements
_Part IV—six critical elements
_Part V—linguistic concepts
_Flowers-Costello Test of Central Auditory Abilities
_Woodcock-Johnson Psychoeducational Battery-Revised
_Clinical Evaluation of Language Fundamentals-Revised
_Phonological Awareness Screen
_Other. Please specify:

14. What other evaluations (via referral or on-site team) are part of your AP diagnostic protocol?

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Part of Standard Test Battery</th>
<th>As Needed, Based on Individual Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological</td>
<td></td>
<td></td>
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<tr>
<td>Educational</td>
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<tr>
<td>Speech-language</td>
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<tr>
<td>Otolaryngology</td>
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<tr>
<td>Neurologic</td>
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<td></td>
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<tr>
<td>Other. Please specify:</td>
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</tbody>
</table>

15. Would you like a copy of the results of this survey? Yes No

Thank you for your time. Please return the completed survey in the enclosed SASE or mail to Dr. Diana Emanuel, Department of Communication Sciences and Disorders, Towson University, 8000 York Rd., Towson, MD 21252-0001. If you receive this survey electronically, please attach your response and send it to demanuel@towson.edu.
APPENDIX B

American Guidance Service
4201 Woodland Road
P.O. Box 99
Circle Pines, MN 55014-1796
800-328-2560
www.agsnet.com

- Comprehensive Assessment of Spoken Language
- Goldman-Fristoe-Woodcock Test of Auditory Discrimination
- Oral and Written Language Scales
- Peabody Picture Vocabulary Test-III

Audiology Illustrated, LLC
111 Lyme Road
Hanover, NH 03755
603-643-9705

- Dichotic Digits
- Frequency Patterns
- Duration Patterns

Auditec of St. Louis
2515 S. Big Bend Blvd.
St. Louis, MO 63143
314-781-8890
800-669-9065
www.auditec.com

- Auditory Fusion Test-Revised
- Competing Sentences
- Dichotic CV
- Dichotic Digits
- Dichotic Sentence Identification
- Dichotic Word Listening Test
- Discrimination of Phonetically Balanced Kindergarten in Noise
- Duration Pattern Sequence (DPS)
- Low-pass filtered lists; NU-6, PBK-50, Word Intelligibility by Picture Identification
- NU-6 with various competitions
- Pediatric Speech Intelligibility Test
- Pitch Pattern Sequence
- Random Gap Detection Test
- Rapid Alternating Speech
- Selective Auditory Attention Test
- Speech in Noise
- Spondee Binaural Fusion
- Synthetic Sentence Identification with Contralateral Competition
- Synthetic Sentence Identification with Ipsi-lateral Competition

Educational Audiology Association
4319 Ehrlich Rd.
Tampa, FL 33624
www.edaud.org
800-460-7EAA

- Children's Auditory Performance Scale
- Fisher Auditory Problems Checklist
- Listening Inventory for Education
- Screening Identification for Targeting Educational Risk

Etymotic Research
61 Martin Lane
Elk Grove Village, IL 60007
847-228-0006

- Quick SIN

Linguisticsystems
3100 4th Avenue
P.O. Box 747
East Moline, IL 61244-0747
www.linguisticsystems.com
800-776-4332
Fax: 800-577-4555

- Phonological Awareness Test

Maico Diagnostics
9675 West 76th Street
Eden Prairie, MN 55344
952-941-4201
Fax: 952-903-4200
www.maico-diagnosties.com

- Hearing in Noise Test

Precision Acoustics
411 NE 87th Avenue, Suite B
Vancouver, WA 98664
360-892-9367

- Competing Environmental Sounds
- Phonemic Synthesis
- Phonemic Synthesis Picture
- Staggered Spondaic Word

Pro-Ed
8700 Shoal Creek Boulevard
Austin, TX 78757-6893
800-897-3202
Fax: 800-397-7633
www.proedinc.com

- Comprehensive Test of Phonological Processing

\(^3^{\text{Many of the speech-language tests are available from multiple distributors but are only listed once.}}\)
- Detroit Test of Learning Aptitude-Fourth Edition
- Expressive One Word Picture Vocabulary Test-2000 Edition
- Gray Oral Reading Tests-Fourth Edition
- Lindamood Auditory Conceptualization Test
- Test for Auditory Comprehension and Language, Third Edition
- Test of Auditory Perceptual Skills-Revised
- Test of Phonological Awareness
- Test of Word Finding, Second Edition
- Test of Written Language, Third Edition
- Token Test for Children

The Psychological Corporation
555 Academic Court
San Antonio, TX 78204-2498
800-872-1726
www.psychcorp.com

- Vigil Continuous Performance Test (Psychological Corporation, 1996)
- Conners' Continuous Performance Test (Conners, 1994)
- Auditory Continuous Performance Test (ACPT) (Keith, 1994b)
- SCAN-C: Test for Auditory Processing Disorders in Children (Keith, 2000)
- SCAN-A: A Test for Auditory Processing Disorders in Adolescents and Adults (Keith, 1994a)
- SCANWARE (Software)
- Test of Phonological Awareness
- Clinical Evaluation of Language Fundamentals, Third Edition
- Photo Articulation Test, Third Edition

Read America
Box 1246
Mount Dora, FL 32756
352-735-9292
Fax: 001-352-735-9294
www.ReadAmerica.net
RAchat@aol.com

- Phono-Grapix

Riverside Publishing Company
425 Spring Lake Drive
Itasca, IL 60143-2079

800-323-9540
http://www.riverpub.com

- Test of Word Finding in Discourse

Slosson Educational Products
P.O. Box 280
East Aurora, NY 14052-0280
888-756-7766
800-655-3840

- Slosson Oral Reading Test

Western Psychological Services
12031 Wilshire Boulevard
Los Angeles, CA 90025-1251
310-478-2061
www.wpspublish.com

- Auditory Discrimination Test

Richard Wilson, PhD
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www.va.gov/621quillen/clinics/asp
(Use this Web site to download word lists for the compact disc.)
Richard.Wilson2@med.va.gov

Tonal and Speech Materials for Auditory Perceptual Assessment
- Dichotic Digits
- Dichotic Consonant Vowels
- Dichotic synthetic sentences
- NU-6 high-pass filter
- Frequency patterns
- NU-6 compression + reverberation
- Spondaic words masking level difference

Speech Recognition and Identification Materials
- Competing Sentences
- NU-6 in babble
- SSI-ICM

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