Section 1:

Introduction to the *MAPA-2*

The *Multiple Auditory Processing Assessment–2* (*MAPA-2*) is an individually administered comprehensive assessment for individuals aged 7 through 14. It is designed to provide information about auditory processing skills in individuals with reported functional listening difficulties. The *MAPA-2* includes administered subtests in three auditory domains—monaural, temporal, and binaural—and a behavioral checklist of listening abilities, the *Scale of Auditory Behaviors* (*SAB*). It is designed for both screening and diagnostic identification of those with auditory processing disorder. It is intended for use primarily by audiologists, speech-language pathologists, and other professionals who need a valid and reliable measure of auditory abilities in school-age children and adolescents who experience difficulties understanding in common listening situations.

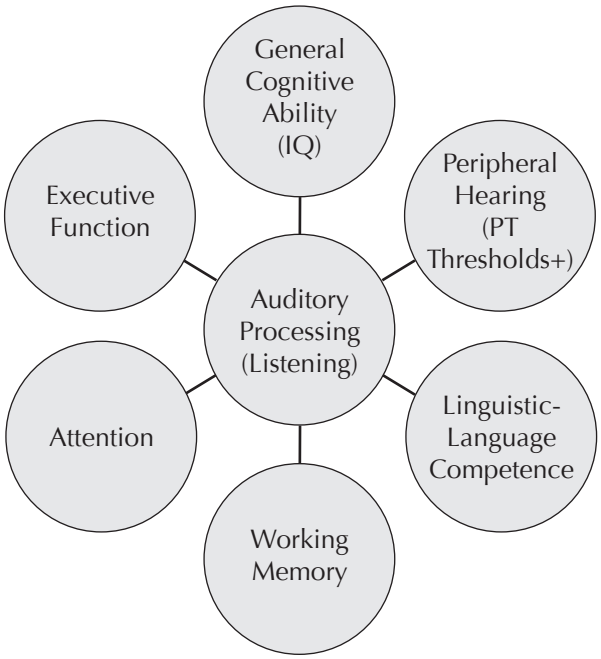
The *MAPA-2* was developed over more than 25 years of extensive research by an interprofessional team of audiologists, psychologists, and speech-language pathologists from several clinics and university research settings (Conlin, 2003; Schow & Chermak, 1999; Schow & Seikel, 2007; Schow, Seikel, Chermak, & Berent, 2000; Shiffman, 1999; Simpson, 1981; Summers, 2003). Beginning in the 1990s, the research to develop the *MAPA* followed the auditory processing disorder (APD) assessment guidelines developed by the American Speech-Language-Hearing Association (ASHA) (1996; 2005) and then, later, the guidelines developed by the American Academy of Audiology (AAA) (2010). The development of the *MAPA* has also been influenced by the seminal work of Dillon, Cameron, Glyde, Wilson, and Tomlin (2012) and the suggestions from DeBonis (2015).

This section provides a review of current understandings of auditory processing and APD and presents an overview of the structure of the *MAPA-2* and descriptions of the subtests.

Auditory Processing and Auditory Processing Disorder (APD)

Listening is a complex behavior involving a variety of cognitive, attentional, auditory, and linguistic skills (Chermak, Musiek, & Weihing, 2017; DeBonis, 2015; Richard, 2011; Sharma, Dhamani, Leung, & Carlile, 2014). When an individual demonstrates persistent difficulties with complex listening activities, in spite of normal hearing thresholds and normal IQ, assessment of auditory processing skills and a diagnosis of APD may be pursued. Historically, researchers and clinicians have focused primarily on the central aspects of auditory processing, but current views recognize that both central and peripheral contributions are involved in successful auditory processing. In other words, auditory processing includes both "bottom-up" (ascending sensory) and "top-down" (descending cortical) factors (British Society of Audiology, 2011; Moore, 2012). For example, subtle peripheral hearing deficits (bottom-up) may not be identified with pure tone testing but may be present and interact with cognitive deficits (top-down) to influence listening ability. Top-down factors that influence auditory processing include attention, working memory, general cognitive ability, linguistic competence, and executive functions (Chermak et al., 2017; de Wit et al., 2016; Katz & Tillery, 2004). While the APD term is being retained in the professions of audiology and speech-language pathology, there is a move toward a diagnostic process that emphasizes "listening difficulty" rather than APD (DeBonis, 2015; Dillon et al., 2012). The approach to the *MAPA-2* is similar, where APD is defined as an overall listening deficit that could stem from many factors (see Figure 1.1).

FIGURE 1.1
Factors Involved in Auditory Processing (Listening)



Prevalence of APD can vary widely, depending on the diagnostic criteria used (Wilson & Arnott, 2013). Auditory processing deficits can occur in isolation but frequently co-occur with other developmental and learning disorders, such as specific language impairment, specific learning disability or dyslexia, attention-deficit hyperactivity disorder (ADHD), and autism spectrum disorder (ASD) (Chermak et al., 2017; Iliadou, Bamiou, Kaprinis, Kandylis, & Kaprinis, 2009; Moncrieff & Black, 2008; Moore, Ferguson, Edmondson-Jones, Ratib, & Riley, 2010; Sharma, Purdy, & Kelly, 2009). Given current known rates of these disorders in school-aged children, best estimates are that 2-3% of school-aged children may have APD, either in isolation or in combination with another disorder (Chermak & Musiek, 1997; Iliadou et al., 2009). However, given the variability in diagnostic criteria used for APD, the lack of a gold standard in assessment, and the broadening of theory and terminology to include listening difficulties of various etiologies, it is possible that prevalence is higher.

Most authorities agree that APD involves one of the following etiologies:

1. Delay in development of auditory skills
2. Disorder in development of auditory skills
3. Lesion in the central auditory nervous system

Most children diagnosed with APD experience the delayed or disordered forms (Chermak et al., 2017), and that is the focus of the *MAPA-2*.

Dillon et al. (2012) have suggested that when discussing APD assessment it is most productive to take a functional approach and assess the variety of factors that can contribute to difficulty in understanding speech in commonly encountered listening conditions. A functional approach using listening tests and behavior checklists allows the clinician to directly approach the assessment and treatment of symptoms of listening difficulty. The *MAPA-2* and its accompanying behavior checklist, the *Scale of Auditory Behaviors* (*SAB*), are consistent with this functional approach and reflect the range of skills highly recommended for assessment of children with listening difficulties or suspected APD (Chermak et al., 2017; DeBonis & Moncrieff, 2008; Emanuel, Marczewski, Nagle, & Fallon, 2015; Iliadou & Bamiou, 2012). As such, the *MAPA-2* can provide the basis for prescribing functional treatments related to specific areas of skill deficit, can be used to document treatment gains, and can also be used in research.

Structure of the *MAPA-2*

ASHA (2005) and AAA (2010) have outlined five behavioral auditory domains for APD testing:

1. auditory discrimination
2. auditory temporal (processing and patterning)
3. dichotic speech (binaural integration and binaural separation)

4. monaural low-redundancy speech
5. binaural interaction

Two other domains, electroacoustic and electrophysiologic, are presented but have received little attention (ASHA, 2005).

Administering a battery that includes tests in all the domains may not be practical and is not the current best practice recommendation. Tests in the following three domains are the most commonly used for assessment: monaural low-redundancy, auditory temporal, and dichotic speech. Chermak, an expert involved in developing both the ASHA and AAA guidelines, has also stated her recommendation that assessment should include a minimal battery of tests in these three domains (2001).

The six core subtests of the *MAPA-2* reflect skills in the monaural, temporal, and dichotic (labeled binaural in the *MAPA-2*) domains. Within these domains, the *MAPA-2* includes monotic, diotic, and dichotic subtests (Jerger & Musiek, 2000), subtests that are language-based, and subtests that minimize linguistic demand (Chermak et al., 2017; Emanuel et al., 2015; Richard, 2011). Two supplementary temporal subtests are available when further assessment in that area is needed.

A comprehensive assessment for APD should include both auditory domain testing and a behavioral listening checklist (AAA, 2010; ASHA, 2005; Iliadou & Bamiou, 2012; Jerger & Musiek, 2000). Therefore, the *MAPA-2* also includes a 12-item behavioral checklist, the *SAB*, that is designed to be used in conjunction with formal auditory testing. The *SAB* can be completed by a teacher, a parent, or another adult who has direct knowledge of the examinee's listening behaviors. Common behavioral characteristics associated with APD included in the *SAB* are difficulty hearing or understanding in the presence of background noise; difficulty following oral directions; inconsistent responses to auditory information; and requests for information to be repeated. It should be noted that these behavioral characteristics are not unique to APD, and individuals with other disabilities can demonstrate these behaviors (Chermak et al., 2017; DeBonis & Moncrieff, 2008; Iliadou & Bamiou, 2012). The *SAB* was included in the previously published version of the *MAPA* and has been normed alongside the *MAPA-2*.

All six subtests of the *MAPA-2* may be used alongside the *SAB* for a preliminary diagnosis. Recent discussion in the APD literature suggests that testing in a single domain coupled with use of a listening checklist may be useful as an APD screener (DeBonis, 2015). The Monaural Domain subtests may be used in conjunction with the *SAB* as a screener, to be followed in some cases by additional tests. APD is typically identified when cognitive skills and hearing are within normal limits. Additionally, most clinical experts strongly recommend that attention, memory, and language be assessed prior to assessing auditory processing skills (Chermak et al., 2017; DeBonis, 2015; Dillon et al., 2012). This requires that APD assessment be performed with a team approach (e.g., audiologist, speech-language pathologist, teacher, psychologist, medical professional, parent).

Monaural Domain

Monaural, low-redundancy speech tests measure an individual's "recognition of degraded speech stimuli presented to one ear at a time" (ASHA, n.d.). Typical monaural tests include competing speech, speech-in-noise, and filtered speech tasks. Functional speech-in-noise difficulties are one of the most common behavioral symptoms in APD. However, as noted above, behavioral reports of these types of listening difficulties are not specific to APD, so controlled testing of monaural skills as part of an APD battery is important (Chermak et al., 2017; Iliadou & Bamiou, 2012). There are two Monaural Domain subtests in the *MAPA-2*:

- **Subtest 1—Monaural-Selective Auditory Attention Test (MSAAT):** The individual hears a list of monosyllabic words and is asked to repeat them as presented. The words are presented separately to each ear, first without competition and then while a competing high-interest story is presented in the same ear. Both target and competition stimuli were recorded by the same speaker, thereby eliminating speaker recognition cues. The signal-to-noise ratio is 0 dB.
- **Subtest 2—Speech in Noise for Children (SINCA):** The individual hears pairs of monosyllabic words and is asked to repeat them as presented. The word pairs are presented separately to each ear, with steady background pink noise in the same ear. The signal-to-noise ratio steadily decreases from +16 dB to 0 dB after every two word pairs.

Temporal Domain

Temporal processing and patterning tests measure an individual's ability to analyze acoustic events over time (ASHA, n.d.). Typical tests in this domain include temporal resolution tasks, such as gap detection and fusion, and temporal patterning tasks, such as tapping pattern, pitch pattern, and duration pattern. Temporal processing is important for the development of "phonemic distinctions, lexical and prosodic distinctions, and auditory closure" (Shinn, Chermak, & Musiek, 2009, pp. 229-230). There are two Temporal Domain subtests in the *MAPA-2*, plus two supplemental tests (described below under "Supplemental Subtests"):

- **Subtest 3—Tap Test:** The individual hears a series of tapping noises presented rapidly in both ears (diotic) and is asked to report the number of taps. Taps are presented at 120-ms intervals.
- **Subtest 4—Pitch Pattern Test:** The individual hears a series of four high and low tones presented in different patterns to both ears (diotic) and is asked to report the pattern.

Binaural Domain

Dichotic speech tests measure an individual's ability to separate or integrate different auditory stimuli presented to each ear simultaneously (ASHA, n.d.). Typical

binaural tests include dichotic digits and dichotic sentence tasks. Most processing of auditory information occurs in three-dimensional space and "requires an online integration of differing and potentially competing information presented to the two ears" (Moncrieff, 2011, p. 316). There are two Binaural Domain subtests in the *MAPA-2*:

- **Subtest 5—Dichotic Digits:** The individual hears a set of six digits presented in both ears and is asked to repeat all digits in any order. Digits are presented under two different conditions, dichotic and diotic. The diotic presentation is supplemental and is used when the examiner wants to analyze the dichotic advantage.
    - Dichotic condition—In this condition, the individual hears a different digit in each ear simultaneously. Three two-digit sets are presented, for a total of six digits for each trial.
    - Diotic condition—In this condition, three digits are presented simultaneously, and the same three digits are presented in both ears. Two sets of three digits are presented, for a total of six digits for each trial. This presentation is more difficult than the dichotic condition.
- **Subtest 6—Competing Sentences:** The individual hears a different sentence in each ear at the same time and is asked to repeat both sentences. In the first set of items, the individual is asked to repeat the sentence heard in the right ear first and then the sentence heard in the left ear. This is reversed for the second set of items.

Supplemental Subtests

The *MAPA-2* includes two additional temporal tests and a strategy for measuring the dichotic advantage:

- **Subtest 7—Duration Pattern Test:** This subtest is similar to Subtest 4. The individual hears a series of four short and long tones, presented in different patterns to both ears (diotic), and is asked to report the pattern.
- **Subtest 8—Gap Detection Test:** The individual hears a series of click pairs with randomly ordered intrastimulus intervals of 0 to 40 ms. The individual is asked to report the number of clicks heard (one or two).
- **Dichotic Advantage Score:** The Dichotic Advantage score is derived by subtracting the Diotic Digits score from the Dichotic Digits score. In both dichotic and diotic listening conditions, there is information masking because the numbers are similar but not identical. The dichotic condition produces a dichotic advantage from spatial separation that is not present in the diotic condition.

Scale of Auditory Behaviors (SAB)

The *SAB* is a 12-item rating scale of listening-related behaviors. Parents, teachers, or another informed adult rank the frequency of observed behaviors on a scale from 1 (frequent) to 5 (never). The items on the *SAB* reflect behaviors that are frequently reported in individuals with listening challenges and auditory processing difficulties. The *SAB* should be used in conjunction with administration of the subtests in at least one *MAPA-2* domain to provide a functional check on the results of domain testing.

Conclusion

Listening difficulties can occur for a variety of reasons and can interfere with academic and social participation. When listening difficulties are present and other causal factors such as hearing, cognition, attention, and language have been ruled out, evaluation of specific auditory processing skills may be recommended. The *MAPA-2* is a standardized, nationally normed assessment that examines skills in three critical domains of auditory processing and also includes a standardized behavioral listening checklist. The *MAPA-2* provides clinicians and researchers with a valid and reliable measure of auditory processing skills and related listening behaviors.