Listening difficulties in children

de Wit, Ellen

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GENERAL DISCUSSION AND CONCLUSION
GENERAL DISCUSSION

Since the introduction of the term “auditory processing disorder (APD)” in the seventies of the last century, the status of the concept of APD is controversial and till today a widely discussed subject in various opinion papers and letters to editors (e.g., Jerger, 1998; Jerger & Musiek, 2000; Katz et al., 2002; McFarland & Cacace, 2006; Cacace & McFarland, 2009; Jerger, 2009; Moore, Rosen, Bamiou, Campbell & Sirimanna, 2013; Wilson, 2018; Moore, 2018; Keith, Keith & Purdy, 2018; Iliadou et al., 2018). The controversy and discussions do not concern the acquired APD, i.e. deficits originating in the central auditory system caused by brain lesion, noise exposure or ototoxicity, or the secondary APD, i.e. cases where APD occurs as a result of transient or permanent peripheral hearing impairment, but concentrates on the developmental APD, i.e. children with normal audiometric hearing and no other known etiology (BSA, 2011; 2018; Moore, 2018).

Already in 1954, Helmer Myklebust observed children in his practice who could hear well, but what they heard was apparently not enough for a good language development (Jerger, 2009). Myklebust gave the following description of the problems of these children:

“One of their fundamental difficulties is that they cannot listen; therefore, they cannot direct their attention selectively to an expected sound. To them the auditory environment does not consist of many individual sounds to be used as the immediate situation demands. Their auditory world is conglomerate; all sounds having equal importance and all being foreground sounds simultaneously” (Myklebust, 1954, pp. 256-257).

Myklebust emphasized that hearing cannot be evaluated as something that is separated from other capacities, such as attention, memory, and language. He introduced the term "auditory disorder" to describe the problems that included not only peripheral hearing sensitivity loss, but also the consequences of problems at higher levels in the hearing system, especially as they affected language development (Jerger, 2009). According to Myklebust (1954, p. 4): “Auditory disorders include any incapacities relating to the reception or interpretation of sound, whether they be physical or psychological”. This description seems to have been the cradle of diagnosing APD.

However, for today’s clinicians and researchers the main discussion point is that it is not clear to what extent APD must be regarded as an auditory-modality-specific disorder and whether APD can be considered as a single diagnostic characteristic of the auditory system. Second, it is not clear to what extent confounding supramodal, cognitive deficits play a role in children who experience listening difficulties and, third, which criteria should be used to define and diagnose these problems. The different disciplines, involved in the care for children who experience problems with listening in daily life, have various perspectives regarding the theoretical conceptualization of APD and how the problems of this group of children should be diagnosed and treated in the clinic (Jerger, 1998; Weihsing, Bellis, Chermak & Musiek, 2013; Magimairaj & Nagaraj, 2018).

The present thesis was carried out to investigate which behavioral characteristics are associated with listening difficulties and APD, to examine the relationship between APD and other neurodevelopmental disorders and the role of top-down cognitive processes in children with listening difficulties. Part II of this thesis was carried out to achieve, in collaboration with Dutch speech-language therapists and audiologists, a uniform and useful definition and working method for the Netherlands, and to combine the knowledge and experience of Dutch speech-language therapists, and audiologists in the field of
signaling, diagnostics and treatment of children with reported listening difficulties. To accomplish these aims, the following research questions were addressed in this thesis:

1. Which characteristics are associated with (suspected) APD in children?  
   *(Chapter 2 and 3)*

2. Which characteristics of children with (suspected) APD overlap with the characteristics of children diagnosed with another neurodevelopmental disorder, such as specific language impairment (SLI), dyslexia, attention deficit hyperactivity disorder (ADHD), and autism spectrum disorder (ASD)?  
   *(Chapter 4)*

3. Are listening difficulties in children aged 8 to 12 related to auditory and/or visual attention skills?  
   *(Chapter 5)*

4. What is a useful definition and working method for Dutch professionals who work with children with listening difficulties in clinical practice and how and by whom should listening difficulties in children be identified, examined and treated?  
   *(Chapter 6, 7 and 8)*

Below, I will summarize the results of the chapters and discuss the added value of the results to the international discussion on APD. Additionally, I will address the answers that I found regarding the main question of this thesis:

- What are the characteristics of children with listening difficulties (LiD) and is an auditory processing disorder (APD) a distinct clinical and identifiable disorder that explains the listening difficulties?

### Characteristics of children with listening difficulties

The overall results of this thesis showed that the complaints of children with listening difficulties in daily life must be taken seriously. In chapter 2 of this thesis, we described a systematic review in which studies were included comparing the performance on different questionnaires and tests of children experiencing listening problems (suspected APD or diagnosed APD) with that of their typically developing peers. We found significant differences between children with (suspected) APD and typically developing children, indicating that the often-reported complaints of children regarding listening in daily life are confirmed via systematic analysis.

We conducted this systematic review because, until now, it was not clear what the evidence for APD and the associated symptoms was. APD was so far defined by criteria and descriptions based on personal opinions and observations without a solid evidence-based basis. APD is included in the International Statistical Classification of Diseases and Related Health Problems (ICD-10; World Health Organization, 2016) and is described herein as “a disorder characterized by impairment of the auditory processing, resulting in deficiencies in the recognition and interpretation of sounds by the brain, caused by brain maturation delays and brain traumas or tumors” (ICD-10-CM code H93.25). However, based on this ICD-10 description of APD, it is still difficult to diagnose children with APD, because distinctive characteristics of developmental APD are not included this description. The diagnosis of APD is currently achieved by using a variety of criteria as the presence of a minimal set of symptoms and the use of non-valid test batteries. Therefore, it is probably not recognized as a disorder in the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5), the standard work for the classification of mental disorders of the American Psychiatric Association (APA, 2013).
Various criteria for APD have been developed by various researchers and working groups (e.g., Jerger & Musiek, 2000; American Speech-Language-Hearing Association [ASHA], 2005; American Academy of Audiology [AAA], 2010). For example, the following broad set of symptoms for APD described by the American Academy of Audiology (AAA, 2010) are used in daily practice: “difficulty understanding speech in the presence of competing background noise or in reverberant acoustic environments; problems with the ability to localize the source of a signal; difficulty hearing on the phone; difficulty following rapid speech; inconsistent or inappropriate responses to requests for information; difficulty following directions; frequent requests for repetition and/or rephrasing of information; difficulty or inability to detect the subtle changes in prosody that underlie humor and sarcasm; difficulty learning a foreign language or novel speech materials, especially technical language; difficulty maintaining attention; a tendency to be easily distracted; poor singing, musical ability, and/or appreciation of music; academic difficulties, including reading, spelling, and/or learning problems” (AAA, 2010, p. 9). APD is used as a diagnosis to summarize these behaviors, but the question is whether the listening difficulties and associated behaviors can be explained by auditory pathology and whether the label APD is the correct label for classifying listening difficulties in children. Strikingly, many of these behaviors also occur in children with other neurodevelopmental disorders, like attention-deficit/hyperactivity disorder (ADHD), specific language impairment (SLI) / developmental language disorder (DLD), dyslexia, and autism spectrum disorder (ASD). Therefore, compliance with a number of behavioral criteria as described above is not sufficient for diagnosing APD and to separate APD from other neurodevelopmental diagnoses.

In our systematic review, we investigated the characteristics of children with listening complaints by using evidence from well-conducted scientific empirical research. We wanted to find out whether APD must be regarded as a deficit specific to the auditory modality or as a multimodal deficit. The results of our systematic review showed that several characteristics are significantly associated with children who were referred for an APD assessment. However, the problems of the children with (suspected) APD were not specific to the auditory modality and the children perform weaker in several areas compared to typically developing children. Various studies revealed that children with listening difficulties have also difficulties with auditory, visual, cognitive, oral and written language tasks. Our systematic review showed that children with listening difficulties compared to typically developing children have:

- Poorer performance on all Auditory pattern tests (Frequency Pattern Test or Duration Pattern Test) and diminished performance in conditions in which the masker and target were spatially separated;
- Lower scores for visual measurements;
- More listening difficulties and poorer listening skills;
- Poorer communication abilities and lower scores on tests for language (grammar, phonology, and vocabulary) and reading;
- Poorer nonverbal intelligence and poorer memory and attention skills;
- Greater psychosocial problems;
- Differences in brain activity and white matter microstructure;
- Reduced transient evoked otoacoustic emission (OAE) suppression effects, and abnormalities in auditory evoked potential latency and amplitude.

When comparing groups of children with a neurodevelopmental diagnosis with groups of children without a neurodevelopmental diagnosis, the significant differences found are related to group level. For example, three studies in our systematic review reported white matter microstructure differences and differences in brain activity in children with (suspected) APD. These results are related to a small group
of children and to differences at group level. Some of the children with listening difficulties indeed have measurable abnormal functioning of the brain, but this is not the case for the vast majority of children. Group differences are explanatory to a certain extent, but we cannot simply apply them to each individual. That is, not all children with listening difficulties meet the broad range of characteristics found in our systematic review. Moreover, the characteristics also do not clarify the possible cause of the listening difficulties. The characteristics that we found in our systematic review are also observed in children diagnosed with other neurodevelopmental disorders.

Chapter 2, in which we presented the systematic review about the characteristics of (suspected) APD, shows that children with listening complaints perform significantly different than their typically developing peers and that these differences are related to auditory and visual functioning, cognition (NV-IQ, attention, and memory), language, reading, physiological measures (e.g., auditory event-related potentials and OAEs), and brain structure and activity. This was also reflected in our response letter (chapter 3), in reaction to the letter to the editor of Dr. Moncrieff (2017). Based on these results, it cannot be concluded that listening difficulties of children are caused only by deficits in bottom-up or top-down processes, but there does seem to be an overlap of these processes. Therefore, we have further investigated the overlap between the various developmental disorders of the listening difficulties in children.

Overlap of characteristics of children diagnosed with various neurodevelopmental disorders

Chapter 2 showed that the problems of children with listening difficulties are multimodal and that the listening difficulties of children may be a consequence of cognitive, language, and attention issues as well. APD is not a clearly defined label and most of the characteristics found in chapter 2 are also suitable for children diagnosed with another developmental disorder. This is why we carried out a second systematic review, in which we investigated whether the performance at different outcome measurements (e.g., questionnaires, auditory processing, language and cognitive tests) of children with suspected APD or an APD diagnosis is different from the performance of children diagnosed with another neurodevelopmental disorder, such as SLI, dyslexia, learning disorder, ADHD, or ASD.

Chapter 4, in which we presented our second systematic review, shows that children with listening difficulties usually perform the same in many tests as children who are diagnosed with another neurodevelopmental disorder. There were no differences in cognitive (intelligence, memory, and attention) and language functioning. Furthermore, children with SLI score the same as children with APD on reading tasks. However, children with listening difficulties score weaker in comparison with children with ADHD on auditory and visual pattern recognition tests. And compared to children with learning problems, children with listening difficulties have more difficulty with directional hearing. Also, the parents of children with listening difficulties assess the children’s listening skills as weaker than the parents of children with a SLI / DLD or dyslexia (measured with the CHAPPS questionnaire).

The results described in chapter 4 (second systematic review) confirm our earlier observation in chapter 2 (first systematic review) that the behavior of children diagnosed with APD have a large overlap with the behavior of children diagnosed with another developmental disorder. It is also possible that multiple labels apply to the same children or that various labels are given to children with similar complaints. This could be explained by the various perspectives of the different professionals to whom children with listening difficulties are referred. Depending on the professional who examines the child, the child may be diagnosed with APD, SLI or ADHD. There is no conclusive evidence from which it can be concluded that APD can be clearly differentiated from other neurodevelopmental disorders with overlapping symptoms.
Are listening difficulties in children an auditory-modality-specific disorder?
The studies presented in chapter 2, 3 and 4 indicate that children with listening difficulties have poorer performance across multiple domains and that APD cannot be differentially diagnosed because of the overlapping symptoms with other neurodevelopmental disorders and because there are no valid methods to accurately do so. In chapter 5, it was hypothesized based on the results of the two reviews and the initial description of APD by Myklebust (1954), that children with reported listening difficulties not only score lower on auditory processing behavioral tests and questionnaires, but also on attention, memory, and communication behavioral tests and questionnaires. This explorative study was set out with the aim of evaluating the influence of these top-down cognitive processes on reported listening difficulties in children aged 8 to 12 years. The results of our explorative study, presented in chapter 5, shows that the problems of children with reported listening difficulties seems to be related to visually attention and auditory attention, working memory, communication skills and listening skills. No evidence was found in our study that the problems of the children who experience listening difficulties were caused by a distorted bottom-up sensory processing deficiency. The children with listening difficulties showed a range of individual performance profiles and no distinctive pattern of psychometric performance was found. Together, chapter 2, 3, 4 and 5, show that listening difficulties in children are multifactorial in nature and that top-down cognitive processes play an important role in the listening skills of children. There is no evidence to support the hypothesis that these listening difficulties reflect an auditory-modality-specific disorder in children. Moreover, based on the conducted studies, it is not possible to separate bottom-up sensory from top-down cognitive processing and to differentiate between auditory processing disorders and language, attention and working memory disorders with the current diagnostic tools which are available in clinical practice. This is supported by Magimairaj and Nagaraj (2018), who indicate that the comorbidity of different neurodevelopmental disorders is often the rule and not an exception, signifying the multifactorial nature of developmental disorders (Pennington, 2006). In addition, the organization and integrated function of de central nervous system further adds to comorbid phenomena (Kraus & Hornickel, 2013).

Integrated framework for listening difficulties
The results of the studies presented in this thesis indicate that there are many possible reasons for poor listening in children. Listening necessarily involves the integration in the brain of bottom-up, auditory “sensory” information with top-down, multimodal “cognitive” information (Moore, 2012). In addition to a well-functioning peripheral hearing and well-processing of the auditory signal (bottom-up processing), listening requires focus to the speech stimuli and the involvement of memory, intelligence, and language skills (top-down processing). The problems of children with listening complaints vary across children: not all children with listening difficulties have memory, language or attention difficulties, and not all children with memory, language or attention difficulties experience troubles with listening. A framework that can be used to illustrate the influence of cognitive, linguistic, and auditory factors on listening is the framework proposed by Magimairaj and Nagaraj (2018), see figure 1. The various factors may play a role individually or jointly in any combination in causing listening difficulties in children. According to Magimairaj and Nagaraj (2018), the heterogeneous profiles of children with listening difficulties reflect combinations of deficits across these factors. This view is supported by the results of the studies presented in this thesis. The results from both systematic reviews shows that top-down cognitive processes, like attention, memory, and language skills, play an important role on listening and in adequately processing auditory stimuli. From chapter 5, in which we presented the explorative study,
we know that the symptoms of children with listening difficulties seem to reflect a complex relationship between skills in auditory, visual, cognitive and language domains.

**Figure 1.** An integrated framework to conceptualize listening difficulties in children (Adopted from: Magimairaj & Nagaraj, 2018).

**APD or listening difficulties**

One of the main questions of this thesis was whether APD can be regarded as a unique clinical entity, caused by an auditory specific disorder or whether the listening difficulties of children are related to or caused by another factor or impairment, for example, language or attention difficulties. Based on the results of the studies described in chapter 2, 3, 4, and 5, it can be concluded that the problems of children with listening difficulties are multifactorial. It cannot be concluded that APD is an isolated disorder that can be differentiated from other developmental disorders. Given the heterogeneous profiles of children with listening difficulties and the substantial overlap in symptoms between the various neurodevelopmental disorders, it can be concluded that auditory processing disorders best can be characterized as a sub-component that may be influenced by other factors instead of categorizing the deficits as a unique clinical condition. In children with listening difficulties, there does not seem to be an auditory processing disorder that manifests itself in a disturbed bottom-up processing. When listening to auditory stimuli, there seems to be a continuous interaction between bottom-up sensory processes and top-down cognitive processes, which makes it difficult to distinguish between the various processes that play a role in listening. This was already described in 1954 by Myklebust, who emphasized that “Auditory disorders is a more inclusive concept than that which emphasizes degrees and types of peripheral deafness” and that “hearing must be evaluated in relation to the total development and behavior of the child and specifically in relation to physical, mental, and emotional development” (Myklebust, 1954, p. 4). This does not mean that there cannot be a specific auditory defect, like for example a hearing speech-in-noise deficit (DeBonis, 2015) or a spatial hearing deficit (Cameron, Dillon, Glyde, Kanthan & Kania, 2014) that could cause the listening difficulties, but using APD as a diagnostic label seems to have little value.
Towards clinical application

Clinical and research decision-making would be greatly simplified if diagnoses were conceptualized as syndromes or disorders that were truly distinct from each other (Rutter & Pine, 2015). However, research has shown that this is not the case. Phenotypic overlap between, for example, autism, and ADHD, is common and the two disorders have the same genetic liability (Rutter & Pine, 2015). Also, in the studies presented in this thesis significantly overlap between symptoms of children diagnosed with various neurodevelopmental disorders is found.

In chapter 1 of this thesis, five possible relationships between the construct APD and other neurodevelopmental disorders were presented. Based on the results of chapter 2 to 5, two possible options for interpreting the problems of children with listening difficulties can be given (see Figure 2).

Figure 2. Two possible interpretations for the listening difficulties (LiD) in children.

ADHD, attention deficit hyperactivity disorder; SLI, specific language impairment.

The first option is that the symptoms presented by children with listening difficulties, despite normal audiometry, could be considered in terms of more well-defined, commonly used and almost completely overlapping learning disorders such as SLI, dyslexia or attention deficit disorders (Figure 2, option 1). In this case, listening difficulties are caused by language, reading, attention, and/or concentration impairments and are a subset or symptom of one of the other neurodevelopmental disorders. However, there is also considerable overlap at the symptomatic level between SLI, ADHD, and dyslexia (Bishop & Rutter, 2008). The evidence for etiological and cognitive overlap disproves a single deficit model as explanation for the frequent co-occurrence of various developmental disorders (Van Bergen, van der Leij & de Jong, 2014). It seems likely that a large part of the overlap is simply a consequence of the fact that these disorders are slightly different manifestations of the same underlying condition (Bishop & Rutter, 2008).

Therefore, instead of distinguishing between neurodevelopmental disorders, it seems more logical to group them all together into an overarching category and treat them as a variant of a common underlying condition. This fits with option 2 in Figure 2. This option represents the view that there is a more general neurodevelopmental disorder or supramodal global deficit instead of a specific disorder in a group of children with listening difficulties, but also in groups of children diagnosed with other neurodevelopmental disorders (Figure 2, option 2). In this general neurodevelopmental disorder, the behavioral difficulties of children (e.g. auditory, language, and attention) serve as markers that can be expressed along a continuum of severity.
Several explanatory models for the assumed comorbidity are available in which the contribution of shared or correlated risk factors to different disorders is included (Thapar & Rutter, 2015). For example, the Causal model, proposed by Bishop and Snowling (2004) and the Multiple cognitive deficit model, proposed by Pennington (2006). Pennington’s model fits the results of our studies and the idea that many of the individual diagnoses are related with each other in clusters, groups, or on a spectrum instead of being truly distinct disorders (Pennington, 2006; Pennington & Bishop, 2009; Moore & Hunter, 2013). Pennington’s Multiple cognitive deficit model, shown in Figure 3, shows that obtaining complete understanding of neurodevelopment disorders is very difficult because of the multiple pathways involved and because of the shared processes at etiologic, neural, and cognitive level (Pennington, 2006). In line with the results of our studies, the model shows that the etiology of complex behavioral disorders is multifactorial and implies the interaction of multiple risk and protective factors, which can be both genetic and environmental. No single etiological factor is sufficient in itself for a disorder. Because of the shared etiological and cognitive risk factors, therefore, comorbidity among complex behavioral disorders is a logical consequence (Pennington, 2006).

**Figure 3.** The Multiple cognitive deficit model (Pennington, 2006). The four levels in the model are: etiologic, neural, cognitive, and symptom, where clusters of symptoms can define complex behavioral disorders, such as SLI, ADHD, and dyslexia. Causal connections between levels of analyses, some of which would include feedback loops from behavior to brain or even to etiology, are omitted from the figure.

C, cognitive process; D, disorder; E, environmental risk or protective factor; G, genetic risk or protective factor; N, neural system.
The approach to listening difficulties in the Netherlands

In the second part of this thesis (Chapter 6 and 7), the opinion and perspectives of Dutch professionals working in audiological centers was presented. A clinical decision by a healthcare professional must be made not only on the basis of the available scientific evidence, but also on the basis of the knowledge and experience of the professional himself and the wishes and perspectives of the client. This is called evidence-based practice (Figure 4). Evidence-based practice concerns the balancing of scientific evidence, knowledge and experience of the professional and the patient’s values in the daily context and making a clinical decision after careful consideration of these elements (Neijenhuis, Lipke-Steenbeek & Houweling, 2014). To examine the knowledge and experiences of Dutch professionals with children with listening problems, the studies in chapter 6 and 7 have been carried out.

From the focus group study (Chapter 6), debates emerged which corresponds with the international discussion about APD: (1) whether or not APD is an auditory deficit and (2) whether or not current test batteries for auditory processing are suitable in diagnosing children with listening difficulties. Among other questions, these specific points were included in the Delphi study, presented in chapter 7, which was done with a small group of Dutch professionals. In the Delphi study, consensus was reached that APD cannot be seen as a separate diagnosis, and that listening difficulties co-occur with dyslexia, ADHD or SLI. This corresponds with the results of the explorative study presented in chapter 5 of this thesis. As described above, it appears that there is not a purely auditory deficit in children with listening complaints, but that there is a complex interaction between bottom-up sensory processing and top-down cognitive processes.

In chapter 8 of this thesis the ‘Dutch Position Statement for children with listening difficulties’ was presented. This position statement is intended to guide professionals working in Dutch audiological centers in the clinical decision-making process in children who are referred to the audiological center with listening difficulties. The statements in the Dutch Position Statement are based on the results of
the systematic reviews presented in chapter 2 and 4, the perspectives of Dutch professionals presented in chapter 6 and the consensus reached as described in chapter 7. Although the Position Statement was delivered earlier than the study described in chapter 5, the statements are supported by the results of the explorative study from chapter 5. A strength of the Dutch Position Statement is that it has been developed in consultation with professionals working with children with listening complaints and that uniformity has been achieved together with professional practice.

In order to determine the statements, the information obtained with the studies described in chapter 2, 4, and 7, was returned to the professionals of Dutch audiological centers by the use of propositions. The professionals could indicate whether they agreed or disagreed with a proposition. When 75% of the respondents agreed, it was included as a statement in the Dutch Position Statement. The final version of the position statement consists of nine statements, agreed on by the professionals of the Dutch audiological centers. These statements concern definition, referral, diagnosis, and treatment of children with listening difficulties. Before the Dutch position statement was published for the professional field, the concept document was presented for review to all audiological centers in the Netherlands. During this review period, the professionals were able to give feedback on the draft version. After processing the comments, the final document was presented to and distributed by the Federation of Dutch Audiological Centers (FENAC).

Implications and future directions
The presence of behavioral criteria alone is not sufficient for a diagnosis. A diagnosis should only be made if, in addition to the presence of deviant behavior, there are also clear problems and limitations in social functioning and at school. This is why we recommend in the position statement to use the framework of the International Classification of Functioning, Disability and Health (ICF-framework) to map the client’s functioning in a holistic manner, instead of focusing on providing a diagnostic label. The child’s listening difficulties can best be described in the ICF domain ‘activity and participation’. By using the ICF framework, all symptoms, whether they are auditory or not, can be described. In addition, there must be multidisciplinary collaboration to map the problems of the children from various perspectives. Because audiological centers in the Netherlands are already set up as multidisciplinary centers, multidisciplinary diagnostics is already done in the Netherlands in most cases in children with more complex problems. Based on the input of the professionals, obtained in the focus group study and the Delphi study, a step-by-step method for performing diagnostics in a uniform way in children referred with listening complaints has been developed and presented in a flowchart in the Dutch Position Statement.

With the Dutch Position Statement, a contribution has been made to the working method of Dutch professionals when it comes to the target group of children with listening problems. However, there is still considerable uncertainty about the management of listening difficulties. Therefore, I recommend to focus further research on the possibilities to treat problems of children with listening difficulties. In addition, based on the various elements of evidence-based practice, it is recommended to investigate in further research the preferences, values and experiences of patients themselves and the parents of children with listening difficulties.

CONCLUDING REMARKS
All results combined, I conclude that listening difficulties exist in children and that these difficulties should be taken seriously, but that there is no evidence for the assumption that the listening difficulties are caused by a defect in the auditory system. We found no evidence in our studies that the listening
difficulties in children are caused by a distorted bottom-up sensory processing deficit only. The studies presented in this thesis suggest that listening difficulties in children are multifactorial in nature and may be a consequence of cognitive (intelligence, attention, and working memory), language, and auditory and visual capacities rather than being uniquely limited to the auditory system. Both bottom-up sensory processes and top-down cognitive processes play an important role in listening. Various neurodevelopmental disorders can be conceptualized as a more general neurodevelopmental disorder, in which listening difficulties of children serve as a marker that can be expressed in a continuum of severity. It cannot be concluded that APD is a single diagnostic characteristic of the auditory system and therefore cannot be considered as an isolated disorder that can be differentiated from other neurodevelopmental disorders. The diagnostic label APD is therefore not suitable for classifying listening difficulties in children.
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