Constructing and Norming Arabic Screening Tool of Auditory Processing Disorders: Evaluation in a Group of Children at Risk For Learning Disability

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Chapter I: LITERATURE REVIEW

1.1. Introduction to the Literature

At the present time, the interest of many scientists and researchers in the field of education and psychology is focused on those individuals with special needs which their level deviated from the level of their normal peers in spite of the availability of the necessary intellectual/mental abilities, especially the lower levels of these abilities in order to find out the problems that hinder their development and obstruct their way towards learning which are known as learning disabilities.

Actually, some school-aged children appear to have hearing problems. They are described by their parents and teachers as children who are uncertain about what they hear, have difficulty listening in the presence of background noise, have difficulty following oral instructions, and have difficulty understanding rapid or degraded speech. Some of these children will have a significant loss in peripheral hearing sensitivity. In others, however, auditory thresholds will be within normal limits. It is assumed that, in a significant proportion of the latter group of children, the listening problems result from an auditory processing deficit, the defective processing of auditory information in spite of normal auditory thresholds (Jerger & Musiek, 2000).

In the past, children with such problems have been labeled as having "central auditory processing disorder" (CAPD). And it was broadly stated, that (Central) Auditory Processing [(C)AP] refers to the efficiency and effectiveness by which the central nervous system (CNS) utilizes auditory information. Narrowly defined, (C)AP refers to the perceptual processing of auditory information in the CNS and the neurobiological activity that underlies that processing and gives rise to electrophysiological auditory potentials. (C)AP includes the auditory mechanisms that underlie the following abilities or skills: sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection), temporal ordering, and temporal masking; auditory performance in competing acoustic signals (including dichotic listening); and auditory performance with degraded acoustic signals (ASHA, 1996; Bellis, 2003; Chermak & Musiek, 2002). (Central) Auditory Processing Disorder [(C)APD] referred to difficulties in the perceptual processing of auditory information in the CNS as demonstrated by poor performance in one or more of the above skills.

In keeping with the goals of maintaining operational definitions, avoiding the imputation of anatomic loci, and emphasizing the interactions of disorders at both peripheral and central sites, however, it seems more appropriate to label such problems as "auditory processing disorder" (APD) (Jerger & Musiek, 2000).

Therefore, An APD may be broadly defined as a deficit in the processing of information that is specific to the auditory modality. The problem may be exacerbated in unfavorable acoustic environments. It may be associated with difficulties in listening, speech understanding, language development, and learning. In its pure form, however, it is conceptualized as a deficit in the processing of auditory input. Often children diagnosed with APD may have received another diagnosis before being seen by an audiologist. The disorder can be confusing for parents, educators, and other professionals working with these children. Children with APD are first diagnosed with attention deficit hyperactivity disorder (ADHD) or learning disabilities in general Later (Young, 1999).

In spite of the international interest given to the investigation and understanding of the nature of APD, Screening tests for children under 6 years old also need to be developed but are limited at this time by the paucity of research regarding effective diagnosis in this age group (Jerger & Musiek, 2000).

1.2. Auditory Processing Disorders (APD)

Hearing impairment is the most common sensory disability worldwide and has a profound effect upon an individual's ability to function at a personal, social, and occupational level. More recent work has shown that hearing difficulties can be caused by disordered auditory processing within the brain across all age ranges (Bamiou & Luxon, 2008). Information is presented verbally in preschool, elementary, and secondary school classrooms, in clinics, and at homes. The listener receives that information auditorily and must process it. Processing information includes an awareness that a signal exists and a recognition that the signal carries a meaning to be interpreted, comprehended, accepted or rejected, responded to, and perhaps remembered. Some children experience difficulties in processing auditory information for communication and learning (Lasky & Katz, 1983).

In recent years, there has been a dramatic upsurge in professional and public awareness of Auditory Processing Disorders (APD), also referred to as Central Auditory Processing Disorders (CAPD). Unfortunately, this increase in awareness has resulted in a plethora of misconceptions and misinformation, as well as confusion regarding just what is (and isn't) an APD?

Bocca et al., (1954) indicate that concern of the field of auditory processing disorders continue to a duration of more than fifty years. They emphasized the importance of assessment of auditory function of clinic part especially of children that there is a doubt of their suffering from continuous disorders. They added that, in Italy a group of doctors began to prepare sensitive tests to know the amount of auditory difficulties that their patients who have harmonious central auditory nervous systems informed. After many years (Kimura, 1961) presented a selective test. Besides he formed a model to explain and interpret the physiology of central auditory nervous system which forms the base of selective perception. However researches' activity on auditory processing disorders of children didn't activate under this term. In the following, the auditory processing disorders will be presented in details through exposing the concept of this disorder, aspects, causes, the auditory processing system and how it is screened or diagnosed.

1.2.1. Auditory Processing Disorder Definition

It would be appropriate to begin talking about Auditory Processing Disorders with a definition of the subject matter. Unfortunately, one cannot simply turn to the dictionary to obtain this most basic grounding (Chermak, & Musiek, 1997). The difficulty in defining APD has stemmed from several factors. It results, in part from the recognition that APD is not a label for unitary disease entity, but rather a description of functional deficits (ASHA, 1996).

Further, APD has been observed in a variety of clinical populations, including those associated with known lesions or pathology of the central nervous system (e.g., aphasia, Alzheimer's disease, traumatic brain injury) and others with suspected but unconfirmed central nervous system pathology or neuromorphological (i.e.,neurodevelopmental) disorder (e.g., developmental language disorder, dyslexia, learning disabilities, attention deficit disorder) (Breedin et al., 1989; Colson et al., 1991; Cook et al., 1993; Keller, 1992; Pillsbury et al., 1995; Strouse et al., 1995).

Characteristically, individuals with APD experience difficulties comprehending spoken language in competing speech or noise backgrounds, and include deficits in dichotic listening, selective attention and temporal processing (Chermak et al., 1989 & Jerger et al., 1987). In addition, related performance deficits in understanding verbal directions, and auditory memory, as well as academic underachievement and reading difficulties, demonstrate the complex linkages between auditory processing and more global cognitive and linguistic functions (Chermak & Musiek, 1992; Sloan, 1992; Willeford & Burleigh, 1985).

Central auditory processes are the auditory system mechanisms and processes responsible for the following behavior phenomena: sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition including, temporal resolution, temporal masking, temporal integration, and temporal ordering; auditory performance with competing acoustic signals; auditory performance with degraded acoustic signals (ASHA, 1996). Central auditory processes involve the deployment of nondedicated, global mechanisms of attention and memory in the service of acoustic signal processing (ASHA, 1996). Therefore, global neurocognitive mechanisms and processes such as attention and language representation are crucial to even the most basic auditory processing (e.g., discrimination and recognition).

Bellis, (2002) defines this disorder as a kind of disability in nervous processing of auditory stimuli that can't be attributed to higher level cognitive or linguistic factors. But these disorders may lead to a correlation of difficulties that are faced in the higher level of language, in learning process, and the functions of communication. Cacace & McFarland, (1998) assert that auditory processing disorders appear only when there is a perceptual defection in auditory system and not in any other place. This means that individuals who suffer from defects in temporal auditory processing and who in the same time are having a temporal sensory disability are not included in the auditory processing disorders.

Jerger & Musiek, (2000) indicate that individuals who suffer from disorders or diseases of nervous origin like aphasia, surgeries of brain injury, malignant tumor, arteriosclerosis, and epilepsy often suffer from auditory processing disorders but the intentional auditory processing disorders occur when all these diseases are absent as a result of functional defection in central nervous system. They assert that by lateness of the maturity of central nervous system of those who have auditory processing disorders in mostly. It is not recommended to diagnose auditory processing disorders for those who are younger than seven years, and they indicate that the best age to diagnose this disorder is 12 – 13 years.

Both of Watson & Kidd, (2002) add that auditory processing disorder is a basic problem in auditory processing that may lead to or have a relationship with academic and linguistic difficulties in learning process, conversation, and language itself (including written language and the skills of reading and spelling) in addition to the relevant social functions. There is a big responsibility that individuals who have disorders in auditory processing expose to social, emotional and behavioral difficulties. The communication defections and correlated learning disabilities may have an opposite influence on the growth of their self-esteem and self respect.

Report of ASHA, (2005) mentions that auditory processing indicates generally to central nervous system efficiency and effectiveness in using auditory information. Accurately, auditory processing refers to perceptual processing of auditory information in central nervous system (CNS) and also in biological nervous activities that form the base of this process and stimulate at the same time the latent physiological auditory abilities.

Further, ASHA, (2005) added that auditory processing includes auditory mechanisms that form the basis of the following abilities and skills: voice position, auditory distinction, perception and recognition of auditory model, in addition to temporal aspects of auditory process involving temporal integration, temporal discrimination, temporal gap detection, temporal ordering, temporal masking and auditory performance in competitive voice signs (dual hearing) and auditory performance through weak voice signs. Auditory processing disorder denotes difficulties in perceptual processing of auditory information in central nervous system that are represented in obvious shortage in one skill or more of the previous auditory skills.

In summary, auditory processing disorder could be defined as difficulties in perceptual processing of auditory information in central nervous system that appear only when there is a functional defection in auditory nervous system and not in another position and without the existence of any mental and nervous diseases that are represented in oblivious shortage in auditory processing skills: voice position, auditory discrimination, perception and recognition of auditory model, in addition to temporal aspects of auditory process involving temporal integration, temporal discrimination, temporal gap detection, temporal ordering, temporal masking; auditory performance in competitive sound signs (dual hearing) and auditory performance through weak sound signs that lead to academic and linguistic difficulties in learning process, conversation, and language itself (including written language and the skills of reading and spelling), in addition to weakness of relative social functions, and a great possibility that individuals who suffer from disorders in auditory processing expose to social, emotional and behavioral difficulties, and communication defects and accompanying learning disabilities may have opposite influence on the growth of their self -esteem and self-respect.

1.2.2. Auditory Processing Disorders Symptomology

The true nature of this disorder is not known, Unanswered questions regarding the nature of auditory processing disorders (APDs), how best to identify at-risk students, how best to diagnose and differentiate APDs from other disorders (Debonis & Moncrieff, 2008). Approximately 2-3% of children are thought to be affected by handicapping disorders known as APD, with a 2:1 ratio between boys and girls (Chermak & Musiek, 1997; Yvette, 2000). Further, Auditory processing disorders result from impaired neural function and are characterized by poor recognition, discrimination, separation, grouping, localization, or ordering of non-speech sounds they may be developmental or acquired. The exact prevalence of auditory processing disorders is unknown, but they are estimated to affect around 5% of school aged children and an even higher proportion of adults (Bamiou & Luxon, 2008).

It is very complicated disorder because other types of childhood disorders may exhibit similar behaviors. Test performance is often influenced by non-auditory factors (e.g., language, memory, motivation, lack of sustained attention, and lack of cooperation). Early symptoms include delayed language development, phonologic and reading disorders, problems of learning through the auditory channel, poor auditory sequential memory. It is crucial that APD is detected at an early age in order to introduce appropriate remediation before the child fails in school (Cacaca & Mcfarland, 1998; Katz, 1962).

APD contrasts with cognitive, language based problems, and/or problems of attention, children with APD are a heterogeneous group, and not all exhibit the same symptoms. Most children with APD process speech normally in favorable hearing conditions. Therefore, tests that use distorted speech, speech in noise, or competing speech must be used to identify the disorder. Some children who perform poorly on an APD assessment battery have no evidence of speech or language problems. Conversely, some children with APD have significant speech or language difficulties. Sometimes, APD tests cannot differentiate between problems of language and attention, and they are simply considered to be co-morbid (Jerger & Musiek, 2000; Demanez, 2004).

Musiek, (2004) indicates that individuals who are doubted in their suffering from disorders in auditory processing may suffer from one or more of the following behavioral traits: the difficulty of understanding the spoken language in competitive messages or annoying backgrounds or environments that involve many disturbance factors and improper responses or disharmonious ones or misunderstanding or frequent demand of repetition and not concentrating and longer duration to respond in oral communicative situations, difficulty in attention concentration, the easiness of distraction, difficulty of direction following or complicated auditory orders, difficulty of voices position specification, difficulty of songs learning or even children's songs, in addition to lack of singing skills and problems in reading, spelling, learning that are connected with. It is an importance to refer to the fact that this list is a clarifying list and doesn't include all difficulties.

In addition to this, these behavioral traits don't restrict only on auditory processing disorders, for example: language disorders, linguistic impairment, hyperactivity of attention weakness, Asperger's presentation so these behavioral characteristics aren't restricted to only those who suffer from disorders in auditory processing but they are aspects of this disorder by which the existence of disorder can be inferred greatly.

Chermak, (1998) denotes that behaviors of auditory processing disorders often include general weakness in listening skills and academic difficulties, distraction and weakness of attention. In a more detailed study (Rosenberg, 2002) denotes that aspects of this disorder differ according to the difference of age. He adds that auditory processing disorder aspects in early childhood are: difficulties in articulation, understanding the spoken language, separating the speech from its own sound background, disability to recall stories and songs, difficulties in concentration on a specified sound, and confusion between words that has one rhyme and general difficulty in understanding speech.

Concerning the stage of pupils in late childhood and the beginning of adolescence, it is found that the following aspects: difficulties in remembering, following speech directions, difficulties in remembering names, learning new words, and others are often ignored when they speak in a less vital manner, difficulties in understanding for those who speak quickly, and always find difficulty in finding correct words during speech. Concerning the adults, their auditory processing disorder aspects are represented in: speaking louder than the others, difficulties of lists and continuous orders remembering, they always need repetition of sentences and words, and they are unable to store information when listening and translating words, or mere interpreting occurs very literally, and they can't listen well in environments that involve noise.

Baran, (1996) indicates that they appear as if their auditory systems suffer from damage although their physiological sense of listening is natural. They often say " Ha, What " and asking the speaker for repeating what he says. Their responses are always late when they participate in oral communication situations. They lack the element of ordering in their performance of tasks, and they never continue task until its end. Baran adds also some aspects of their academic levels that are represented in: weakness of received and expressional language abilities, of skills of reading, writing and spelling, difficulties in taking notes, difficulties in learning foreign languages, weakness of short term memory, and physiological and behavioral problems as a result of weakness of academic achievement skills and language generally.

Finally, it is very important to emphasize that these behaviors aren't diagnosis criteria of this type of disorders, but they are indicators that must force the surrounding people who live with individuals who suffer from these disorders to ask specialized in this field to ensure through essential tests and measures administration. These indicators or behaviors which characterize APDs could be summarized as follow: Behaving as if peripheral hearing loss was present, despite normal-hearing; Difficulty with auditory discrimination expressed as diminished ability to discriminate among speech sounds (phonemes); Deficiencies in remembering phonemes and manipulating them (e.g. in tasks related to reading and spelling, and phonics, as well as phonemic synthesis or analysis); Difficulty understanding speech in the presence of background noise; Difficulty with auditory memory, either span or sequence; Unable to remember auditory information or follow multiple instructions; Demonstrates scatter across subtests with domains assessed by speech-language and psycho-educational tests, with weakness in auditory-dependent areas; Poor listening skills characterized by decreased attention for auditory information; Distractible, or restless in listening situations; Inconsistent responses to auditory information (sometimes responds appropriately, sometimes not) or inconsistent auditory awareness (one-to-one conversation is better than in a group); Receptive and/or expressive language disorder may have a discrepancy between expressive and receptive language skills; Difficulty understanding rapid speech or persons with an unfamiliar dialect; Poor musical abilities, does not recognize sound patterns or rhythms; poor vocal prosody in speech production.

1.2.3. The Auditory processing system:

The result of auditory processing is auditory perception. Katz & Wilde (1994), for example, treat processing and perception as immediate, it takes place in real time. The complex auditory nervous system pathway, comprising a peripheral and a central system, is the prime communication facilitator. The following delineate the main components of the auditory pathway (Musiek & Chermak, 1997).

The cochlea, located in the inner ear is the primary sensory organ for the reception of auditory signals. The initial analyses of frequency (Hz) and intensity (dB) are made here. The organ of corti, located in the cochlea, contains about 23,000 sensory receptor cells that underlie all auditory activity. The hair cells send impulses to the central auditory nervous system (CANS) via afferent or sensory neurons, and also receive impulses travelling from the CANS via efferent or motor neurons. Auditory messages travel to and fro via the eighth cranial nerve: the acoustic nerve, a bundle of nerve fibers from the vestibular system (responsible for balance), and from the seventh cranial nerve: the facial nerve.

The CANS begins at the point where the acoustic or auditory nerve connects at the cochlear nucleus. It is located on each side of the brainstem in the area of the medulla. This is where the initial stage of central processing occurs, and where temporal features of sounds are coded, therefore the ‘timing’ mechanism may be said to be located at this initial level. Fibers from the nucleus connect with the superior olivary complex, an important relay station of the ascending tract, and responsible for binaural listening functions.

Fibers from here arise bilaterally to form the lateral lemniscus: the primary auditory pathway in the brain stem, the transmission lines for ascending and descending fibers through the brainstem. Fibers from here continue to: 1. the midbrain, to the inferior colliculus: a relay centre for transmitting information to the thalamic area, and 2. The medical geniculate body: the highest level of subcortical function before transmission to the cortex.

Another important mechanism in the brainstem is the reticular activating system; activated by auditory signals, it arouses the cortex so that the information can be interpreted, and it discriminates and selects signals for higher transmission. It also functions as a coordinator of visual, somatosensory and auditory stimuli. An inefficient reticular system can cause many difficulties in attention, discrimination, and integration of auditory processing.

Fibers from the medial geniculate body are projected to the temporal lobes of the cortex. Each hemisphere receives projections from both ears, resulting in binaural representation of auditory stimuli in each temporal lobe. Each hemisphere contains a primary auditory area, and second and third association areas surrounding the primary area. The final link that completes the auditory chain is the corpus callosum: a massive bundle of fibers that connects the two hemispheres, and is responsible for cooperation and communication between them.

Briefly, the auditory stimulus travels through the peripheral auditory system to the central auditory nervous system (CANS) that extends from the brain stem to the temporal lobes of the cerebral cortex. The auditory stimulus travels along the neural pathways where it is ''processed'', allowing the listener to determine the direction from which the sound comes, identify the type of sound, separate the sound from background noise, and interpret the sound (Keith & Jerger, 1991).

Models of central auditory processing reflect recent developments in cognitive neuroscience that underscore the highly complex, multistage, and interactive nature of central auditory processing (Chermak & Musiek, 1992). Stimuli are encoded as patterns of neural activity varying in temporal and spatial dimensions (Greenberg, 1996). A network model, emphasizing the distributed nature of information processing within the nervous system, is replacing a pathway model in which information is thought to be processed in specific centers of the brain (Masterton, 1992). Consistent with the network model, perceptual responses to sensory stimuli are mediated across a large number of brain regions involving multiple serial, parallel, and distributed neural networks (ASHA, 1996; Ungerleider, 1995).

These perceptual responses result from the activation, evaluation, and integration of multiple sources of information (Massaro, 1987). The essential role of neurotransmitters and molecular mechanisms triggered by sensory stimulation in facilitating central auditory processing also is becoming clear (Musiek & Hoffman, 1990).

The emerging conceptualization of central auditory processing views information processing as neither exclusively bottom-up (i.e., data driven) nor top-down (i.e., concept driven), rather, interactive networks operating on multiple sources of information provide constraints and corrections to guide pattern identification and interpretation (Elman, 1993).

Top-down processes ensure the assimilation of lower order information consistent with the listener's experience and expectations; bottom-up processes ensure that the listener is alerted to novel information and information incompatible with ongoing hypotheses about the message (Rumelhart, 1984). Extraction and analysis of lower level acoustic segments are guided by contextual processes, which in turn proceed with reciprocal input from bottom-up information sources, an active listener selectively attends, processes data, and imposes higher level constraints to construct the signal or message (Borkowski & Burke, 1996).

The relative contribution of bottom-up and top-down processes is driven by the changing demands of the listening situation. The influence of top-down processes is more substantial when stimuli are presented in degraded form, including noisy environments and linguistically ambiguous contexts (Rumelhart, 1984). For persons with APD who routinely confront internal distortions that degrade the signal, top-down processing exerts a more significant influence in all listening situations, especially in noisy and reverberant environments and when coupled with complex linguistic and cognitive demands (classrooms).

Based on the neuroanatomic structures (figure 1) of the auditory system, CAP efficiency can be broadly defined as the relative ability to attend to specific auditory signals in the presence of background signals, discriminate between them, inhibit undesirable signals, recorder or modify them, recognize them, and assign meaning to them. Obviously, unimpaired reception of sounds is necessary for the function of the auditory system but not sufficient for meaningful communication. The central auditory processing system must be functional and intact for correct interpretation and the resulting meaning to occur (Rammp, 1987).

1.2.4. Biology of Auditory Nervous System

It is essential for the researcher involved in the assessment of central auditory processes to have a basic understanding of the anatomical and physiological bases underlying those processes. Without knowledge of the functioning of the central auditory nervous system (CANS), the full clinical value of the central tests may go untapped. This part provides an overview of the anatomy and physiology of the CANS. Although it is not within the scope of this study to give a complete overview of this subject, the topics discussed herein will provide a basic understanding of the function of the CANS.

Brainstem Auditory Pathways

Several brainstem structures comprise the ascending auditory pathway. These include the *cochlear nuclei, superior olivary complex, lateral lemniscus, inferior colliculus, and medial geniculate body* (figure, 1). (Bellis, 2003, 16):

Cochlear Nuclei-Pons

The most caudal structures in the CANS are the cochlear nuclei (CN). There are three main nuclei: the anterior ventral, posterior ventral, and dorsal. The CN are located on the poster lateral surface of the pontomedullary junction where the pons, medulla, and cerebellum meet. This area is also known as the *cerebellopontine angle* and is a common site of tumors.

The cells within the CN complex are tonotopically arranged. That is to say, there is a one-to-one relationship between tonotopic organization of the hair cells within the cochlea and tonotopic organization of the cells within the CN. This cochlear representation is repeated throughout the ascending auditory pathways. Although the majority of auditory fibers from the CN cross the midline and project contralaterally, many of the fibers remain ipsilateral.

Superior Olivary Complex-Pons

The superior olivary complex (SOC) is medial to the cochlear nucleus in the caudal pons, thus it cannot be viewed on the surface of the brainstem. It receives information from both ipsilateral and contralateral cochlear nuclei. A distinctive feature of the SOC is the presence of 'binaural cells' that are sensitive to time and intensity cues. Since input from the ipsilateral ear reaches the SOC milliseconds sooner than input from the contralateral ear, the SOC is implicated in successful localization, lateralization, and binaural integration.

Lateral Lemniscus-Pons

Composed of both ascending and descending fibers, the lateral lemniscus (LL) is the primary ascending auditory pathway. It extends from the SOC to the inferior colliculus in the midbrain. Like the SOC, the LL cannot be seen from the surface of the brainstem. It contains cell bodies (nuclei) along its length that receive crossed and uncrossed projections from more caudal auditory structures, thus continuing bilateral representation of auditory stimuli.

Inferior Colliculus-Midbrain

The inferior colliculus (IC) is located on the posterior surface of the brainstem and is easily viewed following removal of the cerebellum, It is considered to be the 'way station' for auditory information, as both ICs are connected by commissural fibers. As a result, the IC is another structure that has profound implications in the ability to localize a sound source and other binaural processes. Part of the auditory information received by the IC is projected to the superior colliculus, reticular, formation, and cerebellum for coordination of eye, head, and body movements in reflexive localization toward a sound source. Through the brachium of the IC, auditory information is sent to the ipsilateral medial geniculate body.

Medial Geniculate Body-Midbrain

The medial geniculate body (MGB) is located on the inferior surface of the thalamus, medial to the auditory cortex. It serves as the thalamic relay station for transmission of auditory information. The MGB receives information primarily from the ipsilateral brachium of the IC and projects to the internal capsule where fibers transmit information to the auditory cortex via the external capsule and insula.

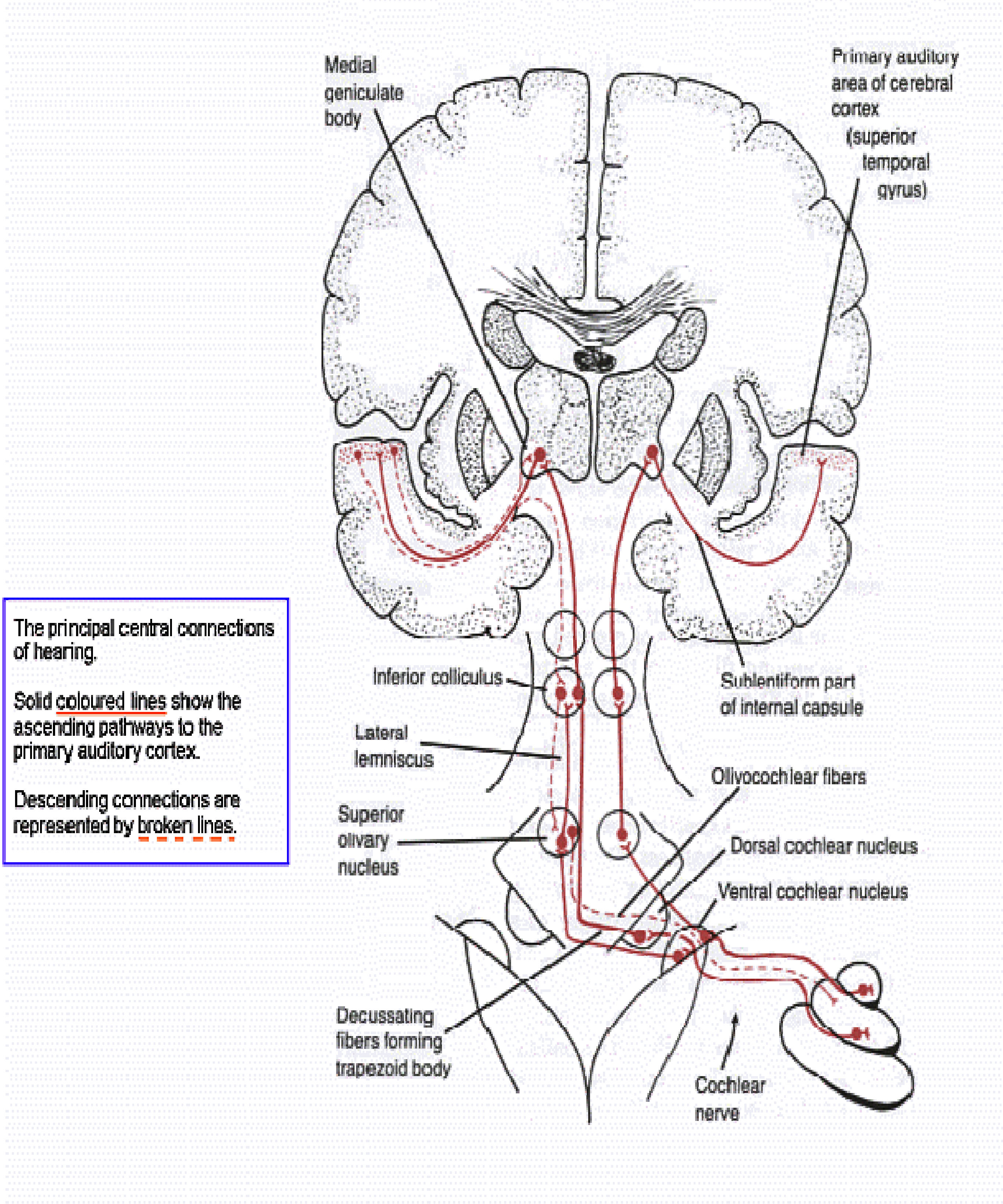

Figure 1. Ascending brainstem auditory pathways, (Bellis, 2003, 16).

The Cerebrum

The primary auditory cortex, Heschl's gyrus, is located approximately two thirds of the way lobe. This upper surface is also referred to as the supra-temporal plane. Heschl's gyrus cannot be observed on the lateral surface of the cortex; instead, the temporal lobe must be removed or displaced inferiorly in order to expose the supra-temporal plane (Figure, 2). The primary auditory cortex is the site of auditory sensation and perception which receive projections from the medial geniculate body via the internal capsule, insula, and external capsule. The primary auditory cortex is known to retain the tonotopic organization of the cochlea.

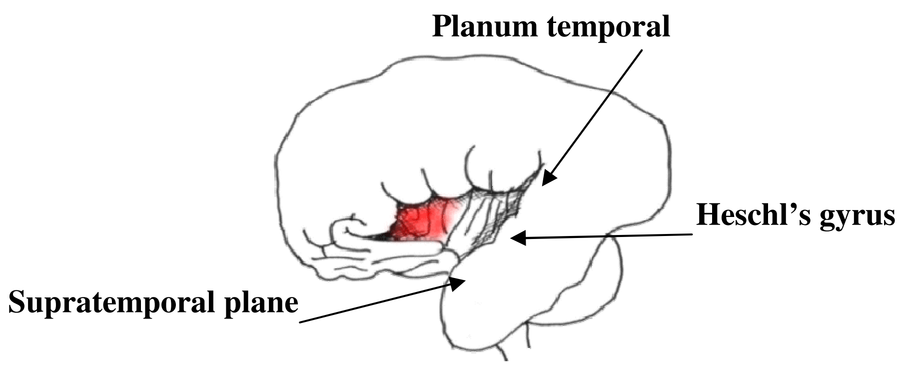

Figure 2. Lateral view of brain with temporal lobe displaced to expose Heschl's gyrus, (Bellis, 2003, 10).

The Corpus Callosum

The primary auditory cortical areas in both hemispheres are not connected directly to each other. Instead, they are connected only through their association cortices which are, in turn, connected to each other via the corpus callosum. As mentioned previously, the corpus callosum is the largest commissural fiber bundle and connects the two cerebral hemispheres.

The corpus callosum is primarily responsible for the communication and integration of information from the two cerebral hemispheres. In the case of auditory function, the left hemisphere is dominant for language and rapid sequencing of the auditory stimuli as well as for analysis. The right hemisphere is dominant for music perception and other acoustic contour recognition and perception of the gestalt. In order to an individual to perform certain auditory tasks-such as dichotic listening, the two cerebral hemispheres must be able to communicate.

Efferent Auditory Pathways

To date, little is known about the efferent auditory pathways. It is known that an efferent system runs from the auditory cortex to the cochlea and parallels the afferent system. Information available indicates that the efferent auditory system includes both excitatory and inhibitory activity, and has significant implications in functions such as detection of a signal in background of noise (Billes, 1996).

Effects of Pathology of the Central Auditory Nervous System

The CANS extends from the level of the low brainstem upward to the auditory cortex. Pathology along any portion of this pathology can result in a variety of auditory symptoms that may be isolated and identified by diagnostic tests of auditory function. Knowledge of the anatomy and physiology of the normal auditory nervous system is critical to prediction of effects of pathology upon the CANS.

Lesion; used to denote any pathological condition, a lesion may be structural, as in the case of a tumor or infarct, or it may be neurochemical or idiopathic (no known etiology). Used in this sense, the term lesion indicates site-of-dysfunction, be it structural or otherwise (Lyons, 2003).

Actually, the effects of pathological conditions upon auditory processing depend on the level of the CANS affected and the extent of the lesion. Unilateral lesions of the primary auditory cortex typically result in contralateral ear deficits upon dichotic stimulation. Lesions involving corpus callosal fiber interfere with the interhemispheric transfer of acoustic information. The effects of brainstem affected and whether the lesion is intra- or extra-axial. And the tables (1) summarize the effects of lesions of the Central Auditory Pathways.

Table 1.

The Effects of Lesions in the Central Auditory Pathways, (Bellis, 2003, 26).

Site of lesion	Effect(s) on Auditory Behavior
Unilateral Temporal Lobe	Contralateral deficit on dichotic listening tasks; impairment of localization in contralateral auditory field.
Bilateral Temporal Lobe	Possible cortical or 'central' deafness.
Brainstem	Behavioral indicators may be unilateral or bilateral depending on locus and size of lesion; may cause deficits in both acuity and processing.
Corpus Callosum	Bilateral deficits on any task that requires interhemispheric integration; left ear deficit on dichotic speech tasks
Efferent Auditory System	Possible difficulty hearing in noise due to disruption of inhibitory function.

1.2.5. Auditory Processing Disorders Models

Auditory processing disorder is a relatively recent construct that has given rise to 2 theoretical models: the Buffalo Model and the Bellis/Ferre Model. These models describe 4 and 5 APD categories (Jutras et al., 2007). In fact, more than 25 years later, APD diagnosis and treatment remain contentious issues. For instance, some researchers doubt the reliability and validity of APD tests (Cacace & McFarland, 2005; Rees, 1981), while others find them acceptable (Musiek et al., 2005). Furthermore, for an accurate APD diagnosis, some hold that the test battery should evaluate modality specificity and include a multimodal assessment (Cacace & McFarland, 2005; McFarland & Cacace, 1995b).

Researchers are not unanimous on this, however. Some question the clinical feasibility of this protocol for at least three reasons: (a) the difficulty of determining whether the disorder is restricted to one modality; (b) the unavailability of clinical multimodal tests; and (c) the lack of trained audiologists to test the various modalities (Musiek et al., 2005). Still others claim that central auditory processing ultra- and interest comparisons would help differentiate auditory from multimodal disorders (Katz & Tillery, 2005). These controversial issues certainly contribute to refine the (C)APD diagnosis and will play a role in improved service delivery to individuals with (C)APD. It is important to mention that the prevalence of(C)APD is still unknown, but it is thought to be around 2%-3% (Chermak & Musiek, 1997).

Based on auditory test results and language and academic difficulties, theoretical models were proposed to better guide clinicians in their interventions with APD patients. Two models have emerged: the Buffalo Model (Katz, 1992; Stecker, 1998) and the Bellis/Ferre Model (Bellis, 2003, 2006; Ferre, 1997). The models are not based on peer-reviewed data. The Buffalo Model includes four APD categories based mainly on the Staggered Spondaic Word (SSW) test, which comprises 40 pairs of partially overlapping bisyllabic words (Katz, 1962, 1968). The first category, Decoding, is linked to problems in the posterior temporal lobe and associated with dysfunctions in the primary and/or associative auditory cortex (Katz, 1987). A child with a decoding problem has difficulty processing auditory information rapidly and tends to respond more slowly (Stecker, 1998).

The second category is Tolerance-Fading Memory. Individuals in this category have difficulty understanding speech in adverse listening situations, along with short-term memory problems and reduced tolerance to noise (Katz, 1992). This is probably linked to frontal or anteriotemporal dysfunction in the cortex (Katz, 1987). The third category: integration, involves difficulties integrating auditory and other types of information, such as visual information (Stecker, 1998). These difficulties might be caused by dysfunctions in the corpus callosum or the angular gyms (Katz, 1987, 1992). The final category is organization. In this case, individuals tend to make sequencing errors. Dysfunctions might be related to a cortical area called the "reversal strip," located in the frontal lobe, anterior temporal lobe, and postcentral gyms (Katz, 1987, 1992).

The Bellis/Ferre Model is composed of three primary APD subtypes-Auditory Decoding Deficit, Prosodie Deficit, and Integration Deficit-and two secondary APD subtypes-Associative Deficit and Output-Organization Deficit. The three primary deficits are associated with dysfunctions in the left and right hemispheres and left/right hemisphere communication. Listening difficulties in noisy environments or when speech is degraded belong to the Auditory Decoding Deficit subtype (Bellis, 2003, 2006). Prosodie Deficit is defined as difficulty understanding the intent of verbal messages, whereas Integration Deficit involves problems with tasks requiring both cerebral hemispheres to cooperate (Bellis, 2003, 2006). The two secondary subtypes involve more than auditory deficits, that is, language or attention disorders. Thus, Associative Deficit is primarily a receptive language disorder, and Output-Organization Deficit is an attention and/or executive function disorder (Bellis, 2003, 2006). The latter subtype might also be caused by an auditory efferent dysfunction (Bellis, 2003, 2006).

Jutras, (2007) examined the applicability of these models to clinical practice. Neither of these models was based on data from peer-reviewed sources. This is a retrospective study that reviewed 178 records of children diagnosed with APD, of which 48 were retained for analysis. More than 80% of the children could be classified into one of the Buffalo Model categories, while more than 90% remained unclassified under the Bellis/Ferre Model. This discrepancy can be explained by the fact that the classification of the Buffalo Model was based primarily on a single central auditory test (Staggered Spondaic Word), whereas the Bellis/Ferre Model classification used a combination of auditory test results. The 2 models provide a conceptual framework for APD, but they must be further refined to be fully applicable in clinical settings.

1.2.6. Etiology of Auditory Processing Disorders

The causes of APD are generally unknown. Birth and developmental histories are often unremarkable and there is no evidence of brain damage (Keith & Pensak, 1991). Early and chronic middle ear infection will put the child at greatest risk for a conductive hearing loss and associated problems of auditory processing (Oliver, 1990). Neuro-maturation of the auditory system is often delayed in this population. APD can also occur in the presence of neurological conditions or other developmental disorders that include learning disability, language impairment, developmental aphasia, developmental dyslexia, attention deficit disorders (ADD), and attention deficit hyperactivity disorders (ADHD) (Musiek et al., 1990; Chermak et al., 1999).

As mentioned in the beginning, the concept of (central) APDs may be traced back to Bocca's audiological findings in adults with brain tumors that affect the auditory areas (Baran et al., 1999). Children with CANS tumors have similar ear deficits to adults, notwithstanding the young brain's capacity for plasticity (Ponton, 1999). In the presence of severe neurological symptomatology, auditory difficulties may not be perceived as a major symptom, even in the presence of grossly abnormal central auditory test results. Conversely, APD may be the first and only manifestation of a space occupying lesion (Musiek et al., 1994) and the auditory deficits may be mistaken for a learning disability.

Preterm infants with low birth weight may suffer from APD which significantly improves with time; however, by the age of 14 years old some of these children will continue manifesting subtle auditory deficits, such as poor auditory memory span, in a significantly greater proportion than the normal birth weight population (Davis et al., 2001).

In addition, Bacterial meningitis is implicated as a cause of auditory processing disorder, but the supporting evidence is inconclusive (Huggoson et al., 1997) Single case reports also indicate that herpes simplex encephalitis can be associated with central deafness in children-that is, central auditory system dysfunction that results in practically no useable hearing (Musiek et al., 1994). Lyme disease, a tick borne infection transmitted to humans by the bite of infected ticks, may have long term condition of auditory processing difficulties (Bloom, 1998) which may persist following treatment. APD may be also be caused by head trauma (Benavidez et al., 1999). Children who sustain closed head injury may suffer from atrophy of the posterior corpus callosum, resulting in auditory hemispheric disconnection (Benavidez et al., 1999).

Low level heavy metal exposure in children may affect sites in the CANS. Blood lead and mercury levels may correlate with auditory brain stem response (ABR) delayed latencies (Musiek & Lee, 1999; Dietrich et al., 1992)) as well as with poorer central auditory processing abilities (Counter et al., 1998) Similarly, prenatal anoxia (Ponton et al., 1999) may also be implicated in higher prevalence of APD. Also, the mild exposure to CO in the air attenuate the amplitude of the eighth cranial nerve's action potential in children, which might be a link to the disorder auditory neuropathy, in which children have normal otoacoustic emissions but a very poor, or absent, eighth nerve action potentials. These children have auditory processing disorders but often have normal hearing "sensitivity" with pure tone testing (Edmon, 1998).

The auditory deficit in stroke in childhood can be quite dramatic, with no behavioral response to sound despite the presence of normal otoacoustic emissions and ABR, as in the case of 3 year old child with Moyamoya disease; (Japanese, "puff of cigarette smoke") is an inherited disease in which certain arteries in the brain are constricted. Blood flow is blocked by the constriction, and also by blood clots (Setzen et al., 1999). There are no systematic studies of APD in the presence of inborn errors of metabolism, although several of these conditions are known to affect central auditory structures with abnormal auditory evoked response potentials. In view of new treatment possibilities, and of the brain's capacity for plasticity, such studies are urgently required (Oka et al., 1996).

Further, a childhood neurological syndrome (Landau-Kleffner) is characterized by acquired aphasia and epileptic seizures, with onset in childhood, the major feature of the disease is the inability to understand spoken language; this has in turn been interpreted as reflecting an impairment of auditory phonological discrimination (Korkman et al., 1998) a generalized auditory agnosia rather than a phonological deficit underlined by insensibility to loudness and a defect in temporal resolution (Notoya et al., 1991) The length of electrical status epilepticus in sleep has a strong negative correlation with receptive as well as expressive language scores (Kaga et al., 1996; Cranford et al., 1996).

The human auditory system is fully developed at birth; however, *myelination* (The formation of the myelin sheath around a nerve fiber) continues for several years in the higher auditory pathways, as reflected in ABR and middle/late auditory potentials indices, which reach adult values around 2 years of age and by 10-12 years of age respectively (Musiek & Lee, 1999) as well as in the improved behavioral performance with age in several behavioral central auditory tests (Baran & Musiek, 1994), Auditory deprivation may have deleterious effects on the organization of the auditory pathways; thus maturation of some aspects of central auditory function may be limited by the onset and duration of the period of deafness period of deafness prior to cochlear implantation (Ponton et al., 1999). Similarly, auditory deprivation may underline delayed maturation of the central auditory pathway in children who have a history of glue ear, and who show significantly poorer performance in behavioral as well as prolonged ABR wave latencies (Hall & Grose, 1993) than normal controls.

Briefly, the known causes of APD include prematurity and low birth weight, genetic histories, head trauma, diseases of the CANS, exposure to lead or carbon monoxide, and other medical diseases like: Landau-Kleffner syndrome, epilepsy, metabolic disorders, cerebrevascular disorders, Lyme disease, and pervasive development disorder.

1.2.7. Other Types of Childhood Disorders Interfering APD Characteristics

The diagnosis of APD is presently complicated because other types of childhood disorders may exhibit similar behaviors. Examples are ADD, ADHD-predominantly inattentive (ADHA-PI), language impairment, reading disability, learning disability, autistic spectrum disorders, and reduced intellectual functioning (Jerger, & Musiek, 2000; Fenimann et al., 1999).

Children with APD exhibit symptoms similar to those with ADHA. There have been long debates as to whether APD and ADD are the same or different entities: however, research by Chermak and others (Chermak et al., 1998) indicates that they are different conditions (Table 2). Predominantly Inattentive Type (Chermak et al., 2002), the audiologists identified six behaviors that were characteristic of children with APD that the pediatricians did not identify with children with ADHD. These were auditory sustained attention deficit, auditory selective attention deficit, difficulty following instructions given orally, reduced rate of information processing, poor memory, and difficulty discriminating speech.

The pediatrician's listed three behaviors characteristic of children with ADHD that the audiologists did not list. These were inattentiveness, daydreaming, and disorganization. However, both groups identified the following five behaviors as being characteristic of their respective populations: academic difficulties, distraction, poor listening skills, asking for things to be repeated, and auditory divided attention deficit. Clearly, one important reason for differentiating between APD and ADHD is that children with ADHD may be treated with stimulant medications but a child with APD is not treated medically (Suess, 2008; Yalcinkaya & Keith, 2008; Keith & Engineer, 1991).

Table 2.

Differential Behaviors of ADHD and APD, (Yalcinkaya & Keith, 2008).

ADHA	APD
Inattentive	Difficulty hearing in background noise
Distracted	Difficulty following oral instruction
Hyperactive	Poor listening skills
Fidgeting or restless	Academic difficulties
Hasty or restless	Poor auditory association skills
Interrupts or intrudes	Distracted, inattentive

A significant delay in general language acquisition should not be considered an auditory processing deficit, even though the child will probably fail most of the APD test battery. In that situation the child should be considered to have specific language impairment and to be treated as such. Finally, children with low cognitive function may exhibit some of the same symptoms as children with auditory processing problems, but they should not be administered an auditory processing test battery; they should be treated for their primary disorder of impaired cognition (Keith, 2008).

1.3. Auditory Processing Disorders Diagnosis

The need to evaluate children suspected of APD with controlled acoustic stimuli has been noted by many (Katz & Wilde, 1994; Marriage et al., 2001; Musiek, 2004; Sockalingam et al., 2004; Cameron & Dillon, 2005). Assessment instruments that are presented outside of an audiology booth fail to control the environmental variables, acoustic features of the test signals, speed and consistency of the signal, and often require visual responses. They measure psychoneurological abilities.

Some important principles that guide diagnostic test construction were delineated by (Katz & Wilde, 1994; Marriage et al., 2001; Musiek, 2004; Sockalingam et al., 2004; Cameron & Dillon, 2005); The first, is ‘the principle of redundancy’, that is a lot more information in the speech signal than is required for intelligibility. High redundancy signals facilitate understanding of speech and are insensitive to lesions of the CANS. Therefore, diagnostic testing must have redundancy reduced speech. This can be done by filtering, time-compressing, and lowering the signal/noise ratio of the speech stimuli. Another principle is the ‘subtlety’ concept, that is, the higher up the CANS the location of the lesion or defect the greater the test sensitivity that is required. A third concept discussed is the ‘bottleneck principle’. According to this principle, ‘neural cogestion’ occurs at the eighth nerve and brain stem, therefore subtle CANS defects before and beyond the bottleneck will not affect speech discrimination ability.

Audiological tests can be divided into two major categories: those involving physiologic measures such as brain-stem response and auditory reflexes, and those requiring a behavioral response. Most of the controversy, mentioned earlier, regarding APD and its assessment revolves around the latter. Behavioral tests generally are of the following paradigm: monotic, one stimulus is presented to one ear at a time; dichotic, one stimulus is presented to either ears, or dichotic, two different stimuli are applied at the same to both ears. Binaural fusion refers to tests that apply portions of unintelligible speech at the same time to opposite ears. Each paradigm was designed to assess a specific process of the CANS.

Although auditory processing disorder may be considered auditory defect, so scientists of audition are responsible for its diagnosis, but (ASHA, 1996) emphasized the importance of co-operation between all scientists of language, speech, audition, nervous sciences and cognitive psychology to assess and diagnose accurately auditory processing disorder. Scientists of language and speech play a unique role in defining and clarifying the factors that have relation to knowledge, communication and language and which in the same time may have a connection to auditory processing disorders. The role of audition and nervous science scientists lies in making sure that auditory nervous system is clear of any physiological defects. Concerning the cognitive psychology scientists, their role is searching for cognitive disorders that are results of auditory processing disorders through multi- sides' assessment of different cognitive aspects.

1.3.1. Criteria of the APD diagnostic tests are represented in:

- An APD should not be a result of peripheral hearing loss.
- An APD should not result from a supra-modal cognitive function like language.
- The deficit should be specific to the auditory modality.

First: Peripheral Hearing Assessment:

Peripheral hearing loss can contribute to listening and learning difficulties, in all likelihood, a portion of the listening and learning difficulties experienced by children with peripheral hearing loss may be attributed to defective processing of auditory information beyond the periphery. Whilst not denying the possible interaction of peripheral hearing loss on central processing, a proportion of children experience listening and learning problems associated with the defective processing of auditory information, in spit of normal auditory thresholds (Jerger & Musiek, 2000). Children with such profile are defined as having an auditory processing disorder (APD). Hence, the first step that the audiologist should take as part of the APD screening process is to rule out peripheral hearing loss as a possible contributing factor to listening and learning difficulties.

The purpose of audiological assessment is to quantify and qualify hearing in terms of the degree of hearing loss, the type of hearing loss and the configuration of the hearing loss. With regard to degree of hearing loss, the audiologist is looking for quantitative information. Hearing levels are expressed in decibels (dB) based on the pure tone average for the frequencies 500 to 4000 Hz and discussed using descriptors related to severity: normal hearing (0 to 20 dB HL), mild hearing loss (20–40 dB HL), moderate hearing loss (40–60 dB HL), severe (60–80 dB HL) and profound hearing loss (80 dB HL or greater) (McCraken & Sutherland, 1991, 12).

With regard to the type of hearing loss, the audiologist is looking for information that suggests the point in the auditory system where the loss is occurring. The loss may be conductive (a temporary or permanent hearing loss typically due to abnormal conditions of the outer and/or middle ear), sensorineural (typically a permanent hearing loss due to disease, trauma, or inherited conditions affecting the nerve cells in the cochlea, the inner ear, or the eighth cranial nerve), mixed (a combination of conductive and sensorineural components), or a central auditory processing disorder (a condition where the brain has difficulty processing auditory signals that are heard).

With regard to the configuration of the hearing loss, the audiologist is looking at qualitative attributes such as bilateral versus unilateral hearing loss; symmetrical versus asymmetrical hearing loss; high-frequency versus low frequency hearing loss; flat versus sloping versus precipitous hearing loss; progressive versus sudden hearing loss; and stable versus fluctuating hearing loss (McCraken & Sutherland, 1991, 13).

Audiological evaluation is also carried out for purposes of monitoring an already identified hearing loss. Once a particular hearing loss has been identified, a treatment and management plan is put into place. The plan may include medical or surgical intervention, prescription of personal hearing aids, prescription/provision of assistive listening devices, skills development through aural (audiologic) habilitation/rehabilitation, or simply monitoring of the condition through periodic assessment.

It is also important that a person's ability to hear using amplification (e.g., personal hearing aids and any assistive listening devices that are used in place of, or in conjunction with, personal amplification) be monitored and documented. This monitoring would include functional gain assessment, real ear measurement, electro acoustic analysis, listening check, and even informal "functional" assessment in the person's typical listening environment (e.g., the classroom, the workplace, the home).

Tests of Hearing and Listening

The audiologist conducts tests of hearing tones. This is called pure-tone audiometry. The results are recorded on a graph called an audiogram. The audiologist also determines speech reception threshold or the faintest speech that can be heard half the time. Then the audiologist determines word recognition or ability to recognize words at a comfortable loudness level.

Pure-tone Audiometry

Pure tone audiometry is the standard measure used in assessment of hearing loss. It has developed in the 1920s. Its purpose is to assess thresholds of hearing in the range of 250 to 8000 Hz. Hearing thresholds are reported for air and bone conduction. During air conduction measures stimuli are delivered through earphones, during bone conduction measures the stimuli are delivered through a bone vibrator placed on the mastoid bone, behind the ear (Humes, 2005).

Audiogram is the graph where the results from the pure tone measurements are plotted in the shape of curves. By comparing these two curves it is possible to determine the type and the degree of the hearing loss. Elevated air and bone conduction thresholds characterize a sensory neural hearing loss; the curves are situated side by side, under the level of 10 dB HL. The pure tone audiometry was performed in the isolated chamber on the "Inter acoustic AC 40"audiometer according to the IS0 389 (1994) recommended measurement standards (Alcin, 2000).

Speech Audiometry

For an accurate assessment of the degree of peripheral hearing loss , the previous studies have proved that routine pure-tone audiometric screening for 7- and 10-year-old children or less could be discontinued but should be continued for 14-year-old children and above (Haapaniemi, 1997), also, the pure-tone audiometry is easily affected by noise and not appropriate for attracting the attention of young children, Hence, the current study preferred to adopt the speech audiometry for screening the study participants.

Speech audiometry was developed for the evaluation of speech understanding (Bess, 1983). Speech audiometric techniques present standardized samples through a calibrated system in order to measure an aspect of hearing ability. Spondaic or spondee words are the speech stimuli used to obtain the speech reception threshold (SRT). A spondee is defined as a two-syllable word spoken with equal stress on both syllables and is excellent choice for determining threshold in speech because it is easy to understand at faint hearing levels. Standardized word lists now include 36 spondees grouped into two lists of 18 words that are phonetically dissimilar and homogeneous in terms of intelligibility.

Most audiologists measure speech thresholds using monitored live voice and use 5-dB HL increments. Familiarization with the spondee words should occur before testing commences because the familiarization results in an SRT that is 4 to 5 dB HL better than that obtained without prior knowledge. Criterion for the SRT is the lowest hearing level at which 50% of the words are identified. The first spondee is presented at the lowest hearing level setting and usually no response occurs. Then the examiner ascends in 10 dB HL steps until a correct response is identified. Spondee threshold is the lowest hearing level at which half of the words are identified correctly followed by at least two ascending series (Bess & Humes, 1995, 3-5; Coninx, 2006).

Word recognition or speech discrimination testing for instance: Adaptive auditory Speech Test (AAST) has been used to qualify speech understanding difficulty and possibly provide information about site of injury in the auditory system. Phonetically balanced (PB) monosyllabic word lists exist and allow the determination of word recognition. Word lists were developed which minimized the difficulties in assessment of patients with limited vocabulary which were unfamiliar with the words. This component of the basic hearing test battery is not a threshold measure but the test is administered supra-threshold (about 30 to 50 dB HL above threshold). A list of 20 or 50 words may be used and the correct percentage is identified. Word recognition score of 90% or higher is considered normal while scores below this value indicate a problem with word recognition. Patients with a conductive hearing loss frequently show excellent speech discrimination scores when test stimuli are sufficiently loud. Patients with cochlear lesions have poorer discrimination scores and those with retrocochlear lesions tend to have even poorer speech discrimination abilities even with normal auditory pure-tone thresholds (Katz & Wilde, 1994; Coninx, 2006).

How to Interpret an Audiogram?

Rubel et al., (1998) denotes that the audiogram (figure 3) is a standard way of representing a person's hearing loss. Most audiograms cover the limited range 100Hz to 8000Hz (8 kHz) which is most important for clear understanding of speech, and they plot the threshold of hearing relative to a standardized curve that represents 'normal' hearing, in dB HL units. They are not the same as equal-loudness contours, which are a set of curves representing equal loudness at different levels, as well as at the threshold of hearing, in absolute terms measured in dB HL or decibel hearing level.

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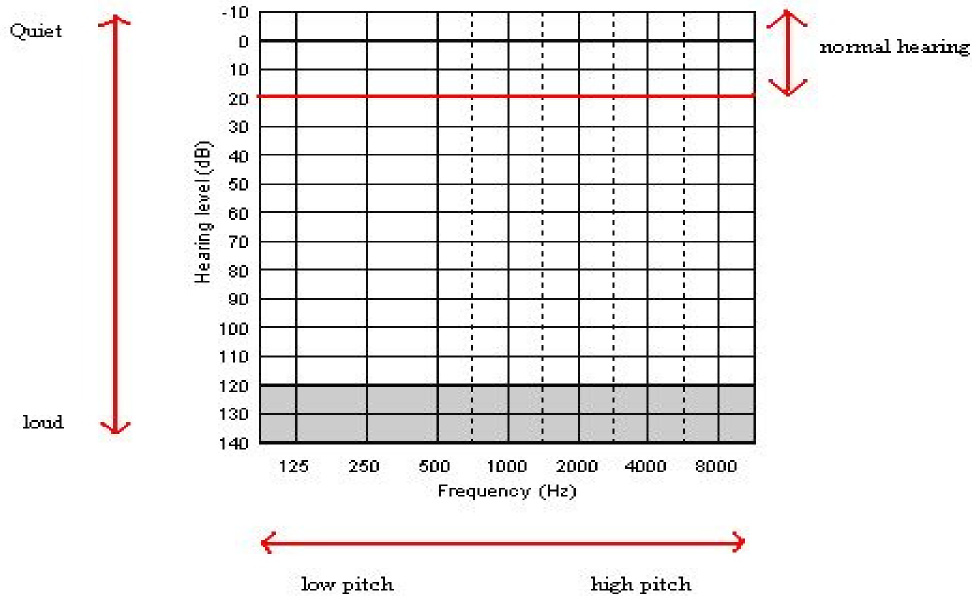


Figure 3. A model for an audiogram

Audiograms are set out with frequency in hertz (Hz) on the horizontal axis, most commonly on a logarithmic scale, and a linear dBHL scale on the vertical axis. Normal hearing is classified as being between -10dBHL and 15dBHL, although 0dB HL from 250Hz to 8 kHz is deemed to be 'average' normal hearing. Each line from left to right represents a pitch or frequency in Hertz (Hz) starting with the lowest pitches on the left side to the very highest frequencies tested on the right side. Examples of sounds in everyday life that would be considered "low frequency" are: bass drum, tuba, and vowel sounds such as "oo" in "who“. Examples of sounds in everyday life that would be considered "high frequency" are: bird chirping, triangle playing, and consonant sounds such as "s" in "sun".

Hearing thresholds of humans and other mammals can be found by using behavioral hearing tests or physiological tests. An audiogram can be obtained using a behavioral hearing test called Audiometry. For humans the test involves different tones being presented at a specific frequency (pitch) and intensity (loudness). When the person hears the sound they raise their hand or press a button so that the tester knows that they have heard it. The lowest intensity sound they can hear is recorded. The test varies for children, their response to the sound can be a head turn or using a toy.

The child learns what they can do when they hear the sound, for example they learned that when they heard the sound they can put a toy man in a boat. A similar technique can be used when testing some animals but instead of a toy, food can be used as a reward for responding to the sound. Physiological tests do not need the patient to respond (Katz, 2002). For example when performing the brainstem auditory evoked potentials the patient's brainstem responses are being measured when a sound is played into their ear. How often hearing should be tested depends mainly on noise exposure. People who are regularly exposed to hazardous noise should have their hearing tested once a year. People with healthy hearing and who are not exposed to much noise should have their hearing tested once every three years.

<u>Secondly: APD should not result from supra-modal factors:</u>

As mentioned before, APD is defined as a deficit in the auditory pathways of the brain that results in the inability to listen to, or comprehend, auditory information accurately, even though normal intelligence is documented (Richard, 2000). Further, Jerger & Musiek, (2002) stress that in order to maintain a clear focus on the accurate diagnosis of APD, it is necessary to view it as a discrete entity, a part from other childhood problems, such as attention deficit/hyperactivity disorder (ADD/ADHD) specific language impairment (SLI) and dyslexia.

As noted by Wilson et al., (2004), children with a supra-modal deficit factors such as IQ, attention, language disorders and memory may perform poorly on tests of auditory processing, not because they have auditory-specific perceptual problems, but because the test in question is sensitive to other processing demands such as attention, memory, cognition and motor skills-which are necessary to perform any behavioral task.

Deficits, such as poor phonological awareness abilities, have been associated with certain profiles of APD (Bellis, 2003; Stecker, 1998). A significant delay in general language acquisition should not, however, be interpreted as an auditory processing deficit, even though the child will probably fail in most of the central auditory processing test battery (Richard, 2001). According to Singh and Kent (2000), language disorders can either be organic in nature (that is, associated with physiological causes such as brain damage or hearing loss), or appear unrelated to organic causes or any other general disability- a condition referred to as specific language impairment (SLI).

Jerger & Musiek (2002) point out that it is very difficult to say that performance on a test which involves speech understanding is due to an auditory-specific perceptual deficit such as APD, rather than to a language disorder such as SLI. According to Friel-Patti, (1999), it is imperative that the speech-language pathologist make every effort to distinguish APD from a subtle language comprehension deficit. APD has been defined as an auditory-specific perceptual deficit in the processing of speech perceptual deficit in the processing of speech input - usually in hostile acoustic environments (Jerger & Musiek, 2002).

Therefore, as noted by Friel-Patti, (1999), many children referred for APD assessment do not exhibit problems in one–to-one conversations, but they do have trouble in multi-talker situations or in conversations with competing background noise. For this reason, language comprehension measured in a quiet, highly structured, one-to-one testing situation will be better than functional performance in the classroom. Specifically, Fiel-Patti, (1999) notes that, the speech-language evaluation of a child with suspected APD should include: general language performance (receptive and expressive), articulation, phonology, and phonological awareness.

In line with Chermak et al., (1999); Bamiou, Musiek & Luxon, (2001); Bellis, (2003); Frei-Patti, (1999); Jerger & Musiek, (2000); Richard, (2000); Wilson, et al., (2004), a multi-disciplinary screening process is recommended to eliminate the influence of supra-modal, denoting that the following principles should be applied when auditory processing tests are stated or formed:

1. Tests of good psychometrical scales should be selected, valid and reliable, that greatly show the efficiency of tests.

2. Auditory processing tests battery should include sub-scales through which different cognitive process can be examined and studied.

3. The responsible for diagnosis process should know many traits of the examinee that include linguistic growth, rapidity of tiredness, cultural background, mother tongue and economic and social conditions.

4. Duration of test must be suitable for person's attention, in addition to keeping a high level of stimulation during testing process.

5. Diagnostician should co-operate with educators and other professionals who are surrounding the examined case during his assessment of auditory processing disorders so as to get acquainted with all the aspects and actual circumstances of case.

6. In case of doubt of the existence of a great linguistic impairment or physiological or psychological problems, it is necessary to exclude these cases and connect them with suitable professionals.

Once it is established that neither peripheral hearing, global IQ, attention, nor language deficits are contributing the child’s listening difficulties. A comprehensive diagnostic assessment can be conducted.

Thirdly: the deficit should be specific to the auditory modality:

Modality Specificity is an important criterion for diagnosing APD, In order for specific topics to be studied with precision and rigor, it is important to have a definition that is unambiguous and straightforward, one that allows hypotheses to be tested and diagnoses to be made. A key conceptual element for differentiating APD from other conditions is derived from the premise that APD represents an auditory perceptual dysfunction; accordingly, it is argued that perceptual dysfunctions are modality specific (McFarland & Cacace, 1995b).

Based on this idea, it is asserted that the primary deficit in APD should be linked directly to the processing of acoustic information; deficits should not be apparent (or at least should be manifest to a lesser degree) when similar types of information are presented to other sensory modalities. Therefore, APD should be distinguishable from cognitive, language-based, and/or supra-modal attentional problems in which modality-specific perceptual dysfunctions are not expected.

Following this logic, APD is defined as a modality-specific perceptual dysfunction that is not due to peripheral hearing loss. However for this approach to be effective, multimodal testing is necessary. This requires an orientation for assessment of APD that is different from what is commonly employed. Although there are other approaches to APD diagnosis, it is believed that this is the simplest and most direct to implement clinically. It is known that this position does not exclude the possibility of modality-specific linguistic or nonlinguistic processes, attention, memory, and so on (McFarland & Cacace, 1995b).

The rationale for adopting modality specificity as a criterion for diagnosing APD is based on the assumption that any given test can be affected by multiple factors

(Cacace & McFarland, 1998; McFarland & Cacace, 1995b). The utility of this distinction has been demonstrated by showing that the detection of a stimulus in noise is influenced by factors such as monetary contingencies. This illustrates that there is not a one-to-one correspondence between a subject's behavioral response and sensitivity to a specific stimulus. More complex "sensitized" tests, often used in APD assessment, introduce the potential for additional factors to influence performance.

Indeed, factors such as attention, motivation, and the complexity of the motor response may not involve central auditory mechanisms. One way to evaluate the impact of such supra-modal processes is to systematically vary the nature of the stimulus while holding all other factors constant. For example, discrimination performance on auditory frequency pattern tasks can be contrasted with discrimination performance on visual color-pattern tasks (e.g., Cacace et al., 1992; McFarland & Cacace, 1997).

If reduced performance is due to auditory-specific processes, then the deficit seen on acoustic versions of the task should be greater than that seen when other stimulus modalities are used. In this way, dissociation between performances on parallel versions of a task using different stimulus modalities can be established. When this is done, interpretations of deficient performance in terms of supra-modal, cognitive, and/or linguistic processes can be ruled out.

1.3.2. Techniques and Methods of Auditory Processing Disorders Diagnosis:

Jerger & Musiek, (2000); Chermak & Musiek, (1997) mentioned three different methods to diagnose auditory processing disorders which are:

- Screening for Auditory Processing Disorders (APD).
- Differential Diagnosis of Auditory Processing Disorders (APD).
- Minimal Test Battery of Auditory Processing Disorders (APD).

First: Screening for Auditory Processing Disorders:

In present time auditory processing disorders screening isn't conducted among schools' students in any formal manifestation of national professional establishments. A number of questionnaires and checklists were used in screening purposes, but there is a controversy about the way of preparing ideal screening procedures and the kind of tasks that these procedures must include. In addition to these lists aren't specialized for auditory processing disorders. It is importance to discriminate between screening tests and diagnostic tests. The aim of screening is mere recognition of children who suffer from auditory processing disorders among their peers without defining the kind of cognitive problems or the degree of its worseness as a result of this disorder (Bellis & Ferre, 1999). The following principles should be followed in designing and preparing filter of auditory processing disorders (Jerger & Musiek, 2000):

1- Filter tools should include necessary tasks to specify efficiency of auditory stimuli processing like tasks that measure skills: sound position, auditory discrimination, perception and recognition of auditory model and temporal aspects of auditory process.

2. Any screening tool whether observation cards, or questionnaire or a test, must be of acceptable psychometric standards.

3. Filter tool should include a means through which audition safety can be checked, for example it should include an interview in which examinee's medical register is got and making sure of this through interviewing the examinee.

4. Screening procedures should involve some cognitive factors like attention and language as clear indicators of this kind of disorder.

5. This procedures should be characterized by brevity.

Screening via Questionnaire

Procedures for screening can include observation of suspect behaviors via questionnaires. Examples of suspect behaviors include:

- Difficulty in hearing and/or understanding in the presence of background noise.
- Difficulty in understanding degraded speech (e .g. rapid speech, muffled speech).
- Difficulty in following spoken instructions in the classroom in the absence of language comprehension deficits.
- Difficulty in discriminating and identifying speech sounds, and
- Inconsistent responses to auditory stimuli or inconsistent auditory attention.

The development and validation of screening questionnaires for school-aged children should be based on accepted psychometric principles. There should be clearly defined pass/refer criteria, and questions should reflect identified suspect behavior,

Screening via Test

A direct screening test procedure should include the following elements:

- A dichotic digit test consisting of two digits in each ear, using a free-recall response mode. The use of digits minimizes the linguistic load imposed by less well-learned speech tokens.
- A gap-detection test in which a short silent gap is inserted in a burst of broad-band noise. Gap detection samples temporal processing, a key dimension of speech processing.

Differential Diagnosis of APD

Jerger & Musiek, (2000); Chermak et al., (1999), asserted the following assumptions for the differential diagnosis of APD:

- Auditory processing problems can occur independently or can coexist with other, non auditory disorders in the following combinations: a pure auditory processing disorder, an auditory processing disorder and a disorder or disorders in other modalities (i.e. ., multi sensory), a disorder that initially appears to be auditory, but actually is non auditory, or a disorder that initially appears to be non auditory but is actually auditory. Auditory processing and methods of assessing auditory processing can be influenced by deficits in other disorders that impact auditory function, including: ADHD, Language impairment, Reading disability, Learning disability, Autistic spectrum disorder, and reduced intellectual functioning.

- Some of the audio logic procedures presently used to evaluate children who "do not seem to hear well" fail to differentiate children with auditory versus non auditory problems.

- In assessing children suspected of having an APD, one is likely to encounter other processes and functions that may confound the interpretation of test results. In order to effectively differentiate APD from other disorders with similar symptomatology, the examiner must consider the following relevant listener variables: attention, auditory neuropathy, fatigue, hearing sensitivity, intellectual and developmental age, medications, motivation, motor skills, native language, language experience, language age, response strategies and decision-making style, visual acuity.

- The design of effective test instruments requires consideration of the following task variables: Cognitive demands (memory, attention), floor and ceiling effects, learning and/or practice effects, linguistic demands, response mode. Although a number of diagnostic procedures are in current use, many have problems because listener and task variables are not satisfactorily controlled.

For improving strategies in APD assessment, Meister, (2004); Musiek & Jerger, (2000) added the following principles that should be put into consideration:

- It is important to compare analogous tasks from multiple sensory modalities. For example, a child with an APD might perform poorly on an auditory task but not a visual task, whereas a child with both auditory and visual processing deficits might perform poorly on both tasks. Some children with either reduced intellectual function or ADHD might also perform poorly on both tasks.

- It is important to employ test materials that control for linguistic variables, ranging from tasks with minimal or no linguistic demand to those that systematically manipulate linguistic variables; the linguistic parameters should be clearly specified. These strategies will assist in differentiating APD from poor performance related to language difficulties.

- It is important to use contemporary psychophysical methods that permit the control of stimulus presentation and response selection and allow the flexibility to employ a variety of feedback options.

- It is important to minimize memory load. If a test depends on remembering information, poor performance may be the result of a memory deficit rather than an auditory processing deficit. For example, deficits in memory processes have been identified in children with learning disabilities and in children with attention deficits.

- It is important to employ a simple response mode in order to minimize the confounding effects on auditory processing of sensory motor impairments, speech production disorders, and problems in motor learning.

- Computer-controlled adaptive psychophysical procedures are recommended. The use of such techniques maximizes test efficiency and minimizes floor and ceiling effects.

- A team approach to assessment provides further validation of the differential diagnosis. Moreover, it is important for management planning. At least, the team should include an audiologist and speech-language pathologist along with parents and teachers. Other specialists can be consulted as needed.

Minimal APD Test Battery

There are three possible approaches to the construction of a minimal test battery for APD in school children, (Noffsinger et al., 1994; Kraus et al., 1995; Willeford &

Burleigh, 1994; Bellis, 1996), (1) behavioural tests, (2) electrophysiological and electroacoustic tests, and (3) neuroimaging studies.

Behavioural tests have the advantage of being widely available and relatively easy and inexpensive to administer. There is also a body of information relative to performance characteristics. There is a disadvantage, however, that results may be easily confounded by extraneous variables. Electrophysiologic and electroacoustic tests have the advantage of being influenced less by extraneous variables. The disadvantage, however, is that they are more time consuming and more expensive to administer. Moreover, facilities for such testing are not widely available. It is noteworthy; nonetheless, that many behavioural test paradigms can be incorporated within electrophysiological procedures, thus providing both performance measures and gross site-specific information from the same test session.

Neuroimaging holds great promise as a tool for the assessment of auditory processing. A number of tasks that have been defined in the behavioural domain are already in clinical use in imaging laboratories, with well-defined norms. Others, particularly tasks involving discrimination paradigms, are evolving toward clinical applicability. All of these tasks have been applied in either clinical or experimental settings. It is the case, however, that neuroimaging shares with electrophysiological testing the disadvantage of relatively high cost and limited availability. In addition, the participants felt that an approach focusing on behavioural tests and supplemented by electrophysiological and electroacoustic testing held the greatest promise as a test battery for APDs. Potential behavioural measures include (Jerger & Musiek, 2000): Measures of detection (e .g., the pure-tone audiogram and temporal integration tasks); Measures of supra threshold discrimination (e .g., difference limens for frequency, intensity, and/or duration; temporal ordering/ sequencing tasks; temporal resolution tasks; backward/forward masking tasks; masking level difference[MLD]); sound lateralization; and spatial localization; and Measures of identification (e .g. the recognition of phonemes, syllables, words, phrases, and sentences).

There are differing circumstances in which each of these delivery modes is most appropriate. In the case of dichotic tests, the dichotic mode is obviously essential. However, monotic assessment is also essential to ensure that significant ear asymmetries are detected. Some measures (e .g. tests of spatial localization) may entail diotic stimulation. Finally, some tasks (e .g. temporal ordering) may be presented in all three modes. Participants considered the following potential electrophysiological and electroacoustic procedures: Otoacoustic emissions, immittance audiometry, auditory brainstem response (ABR), auditory middle latency response (AMLR), auditory late response (ALR), mismatched negativity response (MMNR), event-related responses (ERP).

1.3.3. The Administration of Central Auditory Processing Disorder Tests:

Historically, tests of central auditory function have been categorized in a variety of ways. For example, the ASHA Committee on disorders of central auditory processing (ASHA, 1990) divided central tests into monotic, dichotic, and binaural tests. Katz, (1994) discussed non speech-based, monosyllabic, spondaic, and sentence procedures, and Bellis and Ferre (in press) separated tests of central auditory function into two broad categories: those that add information to the signal and those that take away information from the signal.

Recently, Cameron, (2005) identified four categories that are considered vital in CAP evaluation: temporal resolution; temporal sequencing; binaural integration; binaural interaction. In addition, the APD behavioral tests classification of Jerger & Musiek, (2000): Measures of detection (e .g., the pure-tone audiogram and temporal integration tasks); Measures of supra threshold discrimination (e .g., difference limens for frequency, intensity, and/or duration; temporal ordering/ sequencing tasks; temporal resolution tasks; backward/forward masking tasks; masking level difference[MLD]; sound lateralization; and spatial localization); and Measures of identification (e .g. the recognition of phonemes, syllables, words, phrases, and sentences).

The administration of detection measures has already discussed before under the first criterion of APD diagnosing (peripheral hearing assessment), hence, only the administration of temporal aspects measures (temporal resolution; temporal sequencing; binaural integration; binaural interaction) and identification measures (e .g. the recognition of phonemes, syllables, words, phrases, and sentences) will be discussed as follow:

- Administration of the temporal resolution deficit diagnosing tests:

Temporal resolution is a general term for a range of skills involving perception of the time course of an auditory signal. It includes the ability to detect changes in the duration of auditory stimuli, and the ability to detect silent gaps between auditory stimuli (Singh & Kent, 2000). If a temporal resolution is poor, a listener's ability to distinguish and identify rapidly presented speech sounds may be affected. The Random Gap Detection Test (RGDT) (Keith, 2000), specifically assesses the ability to detect small gaps in an auditory signal that does not differ in frequency, and is referred to as a within- channel gap detection test.

In the administration of RGDT, pairs of tones ranging from 50 to 4000 Hz are presented binaurally at 55 dB HL. Each tonal pair is presented with a silent gap between them, ranging in duration from 0 to 40 msec. One each of nine gap durations between 0 and 40 msec are tested for each stimulus. The gap detection threshold is defined as the lowest interpulse intervals at which two tones are consistently identified. One practice trial of nine tone pairs is provided, Keith, (2000) and Bellis, (2003). A participant is only considered to be outside normal limits on the RGDT if his or her gap detection threshold exceeds 20 milliseconds.

- Administration of the temporal sequencing deficit diagnosing tests:

Temporal sequencing involves the perception and processing of the order of two or more auditory stimuli as they occur over time. Temporal sequencing helps a listener to recognize the acoustic contours of speech. This contributes to his or her ability to extract and use prosodic cues- such as rhythm, stress and intonation- to identify and segment the key words in a sentence. Temporal sequencing can be assessed using the child's version of the Pitch Pattern Sequence test (PPS; Pinheiro, 1977).

In the administration of the test, various pitch patterns are presented under headphones at 50 dB sensation level (SL) (re pure-tone average (PTA) for 500, 1000 and 2000 Hz, tones). Each consists of 3 consecutive tone bursts made up of high-pitch and low-pitch tones. The listener is required to verbalize the pattern, e.g., high low-pitch. If the child is unable to complete the verbal condition, a non-verbal condition is administered whereby the child is required to hum the pattern. Twenty tone pairs are presented binaurally to ensure the child can distinguish high and low tones. Ten tone triplets are then presented to the right ear as practice. Thirty triplets are second for each ear.

Although the ability to score with in normal limits on the PPS requires the listener to discriminate differences in pitch, as well as to perceive and recall order, the frequencies used are sufficiently far apart that pitch perception is not believed to limit ability in the PPS test. According to Medwetsky, (2002), the non-verbal condition of the PPS provides an indicator of a child's overall pattern perception and temporal sequencing ability whilst the verbal task provides additional information on auditory-linguistic integration.

- Administration of binaural integration deficits diagnosing tests:

Binaural integration is the ability of a listener to process different information presented to the two ears at the same time. This process also involves working memory and divided attention. Poor performance in binaural integration may be expressed in the behavioral symptoms of difficulty hearing in background noise, or difficulty listening to two conversations at the same time (Bellis, 2003). Binaural can be assessed using the dichotic digits test (Strouse, 1998).

In the administration of the dichotic digits tests, two different pairs of sequential digits are presented under headphones to each ear simultaneously at 50 dB SL (re PTA). The child is required to repeat back all the digits heard, regardless of order. Ten single digits and 10 double digits are presented dichotically as practice. Forty double digits are then presented and scored for each ear.

- Administration of binaural interaction deficits diagnosing tests:

Binaural interaction refers to auditory processing involving both ears and their neural connections (Singh & Kent, 2000). Two auditory functions that are important in everyday listening conditions that rely on binaural interaction are localization of auditory stimuli, and detection of signals in noise, (Bellis, 2003). The ability to locate the source of a sound depends on the capacity of the central auditory nervous system to detect, perceive and compare small differences in the arrivals time and intensity of signals reaching the two ears. The ability to understand speech in a background of noise can be related to the ability of the listener to use binaural cues to differentiate the location of the sound source from the location of the noise.

Binaural interaction can be used using the Adaptive Auditory Speech Test in binaural noise (AAST bin-noise; Coninx, 2006). The Adaptive Auditory Speech Test (AAST) assesses the Speech Recognition Threshold (SRT) under quiet and noisy conditions. Actually it was designed especially for young children starting from 3-4years old, but it can be used for adults as well. The procedure is minimally dependant on the person's vocabulary. Only 6 easy words are used and the test subject has to point at a picture to identify the word. The test is already established in many languages. In German, Dutch, and English, for example, the test uses spondee words (such as airplane, toothbrush, football etc.) or tri-syllable words in case of spondee words absence in a particular language because both of them have a redundancy comparable with short everyday sentences (Coninx et al., 2009).

The AAST in bin-noise is a closed testing procedure. The testee sees six pictures. One of the test words is presented binaurally in the beginning at 90 dB SPL (dB sound pressure level — for sound in air and other gases, relative to 20 micropascals (μPa) = 2×10^{-5} Pa, the quietest sound a human can hear. This is roughly the sound of a mosquito flying 3 meters away) in a background of binaural noise at 70 dB SPL or shortly the first word is presented at 20 dB SNR (dB signal to noise ratio, whereas 0dB SNR means that the word sound level or signal is equal to the sound noise level and -10 dB SNR means that the signal is lower than the noise sound level with 10 dB SPL) and the testee tries to identify it by pointing at one from the six pictures, the program stops automatically after seven wrong answers; after every correct answer, the next word is presented with 3 dB SPL lower volume. After every wrong answer, the volume is turned up by 6 dB SPL. This up-down-method adapts the presented stimuli to the speech recognition threshold in binaural noise; the presentation of the stimuli, the processing of the testee's responses and the analysis is carried out by the AAST program (Coninx, 2006).

Actually, the listening in specialized noise – continuous discourse test (LISN-CD) is another test for assessing the binaural interaction which produces a virtual three-dimensional auditory environment under headphones and runs on software on a personal computer, the processing simulate a target talker and some competing talker's voices arriving from various directions in auditory space (0º and ±90º). The child's task is to follow the story being spoken by the target talker, and the audiologist adaptively adjusts the signal-to-noise ratio to find the ’’just understandable’’ threshold. By comparing the thresholds under different conditions (same talker versus different directions) a diagnosis can be made of the ability to use different cues to suppress noise, and if there is a disability, the type of processing skill that seems to be deficient (tonal or spatial skills).

The child in LISN-CD is following a story spoken by the target talker, which might be affected by the child’s vocabulary, whilst the procedure of AAST in binaural noise is minimally dependant on the person’s vocabulary, because only 6 easy words are used and the test subject has to point at a picture to identify the word. Also in the LISN-CD, the audiologist adaptively adjusts the signal-to-noise ratio to find the ’’just understandable’’ threshold, while in AAST in binaural noise, after every correct answer, the next word is presented with 3 dB SPL lower volume automatically. And after every wrong answer, the volume is turned up by 6 dB SPL automatically. This up-down-method adapts automatically the presented stimuli to the speech recognition threshold in binaural noise; the presentation of the stimuli, the processing of the testee’s responses and the analysis is carried out by the AAST program, the audiologist or even the educator has no serious role than to compare the SRT in binaural noise to the calculated norms to interpret the results of the child. Further, the AAST itself has the option to work under a condition of quietness to detect the peripheral hearing loss in dB SPL units, in order to save the time and the effort.

The SCAN-3 is a test battery for auditory processing disorders includes three Screening Tests: Gap Detection: Indicates presence of a temporal processing problem which may influence the ability to comprehend running speech; Auditory Figure Ground (+8dB SPL): Tests ability to listen with background noise; Competing Words (Free Recall): Dichotic listening task (poor performance may indicate lack of maturation or abnormality of the auditory nervous system), There are also questions concerning the impact of language level and interpretation of SCAN-3 results, (Bishop

& Dawes, 2007). Hence, the current study attempts to develop the Arabic version of AAST in quiet as a peripheral hearing tool and in Binaural noise as a binaural interaction deficits diagnosing for diagnosing the ADP in the Egyptian children.

- Measures of identification (e.g., the recognition of phonemes, syllables, words, phrases, and sentences).

The ability to discriminate and identify speech sounds is a prerequisite for phonological awareness, Further; Phonological awareness itself is an important part of the Auditory processing which refers to an individual's awareness of the sound structure, or phonological structure, of a spoken word. It includes the ability to auditorily distinguish units of speech, such as a word's syllables and a syllable's individual phonemes (Anthony & Lonigan, 2004).

The frequent available Phonemes identification task is presenting three pictures to the children. The target phoneme is then pronounced along with a word that started with the same phoneme. The child’s task is to select the picture that started with the same sound that the target word started with. Only consonants were used as target phonemes and articulated as sounds. All of the target words were CVC (consonant-vowel- consonant) words thirty items were administered to the children (Vloedgraven & Verhoeven, 2007). The vowels are not involved in this kind of tasks.

Recently, the phoneme identification ability is being evaluated using the "testate" Test (Coninx, 2005, 2009), “teetaatoo” is a word free test for measuring the ability of the child to identify the Phonemes. There is no isolated phonemes are used, but mini -syllables in two sets:

- C-set contains consonant followed by the same vowel. For instance ba, sa, and da.
- V-set contains vowel followed by the same consonant. For instance ti, ta, and tu.

In the audio Track software, the child will hear a consonant-vowel syllable (CV). In a particular test set, the C might be constant and the V changing (tee, taa, too etc). The target CV is presented as the stimulus by clicking a red cell. The response alternatives are being presented by clicking the blue cells. The child is responding by dragging the red cell to the selected blue cell.

A Model of a Minimal APD Battery:

According to what mentioned before, the following test battery based on the behavioural measures is recommended in order to provide the minimum amount of information necessary for the diagnosis of APD in school-aged children. Some clinicians may choose to carry out additional testing; however, the set of procedures listed below is suggested as the minimum necessary test battery:

- Assessing presence and degree of peripheral hearing loss
- Performance-intensity functions for word recognition-essential for the exploration of word recognition over a wide range of speech levels and for comparing performance on the two ears.
- A dichotic task (e.g., dichotic digits, dichotic words, or dichotic sentences)-a sensitive indicator of an auditory processing problem.
- Duration pattern sequence test-a key measure of auditory temporal processing.
- Temporal gap detection-a key measure of auditory temporal processing.
- Actually, constructing a full battery for diagnosing all the above disorders of Auditory Processing is so expensive for a one working thesis, so what the current study will try to achieve in this thesis, selecting two Aspects from the most common Auditory Processing Disorders to be diagnosed.

1.4. Present status of ADP in Egypt and the selected two aspects of APD by the current study to be diagnosed:

In Egypt, clinical services of APDs began in 1985. This was achieved through a multistage process including development of a test material (paper and pencil) in Arabic language for adults and children (1985, 1994) and establishing a protocol for testing. A multidisciplinary diagnostic approach has been developed over years. Recently, Weheiba (2009) made a standardization of two binaural integration tests (dichotic digits and dichotic rhyme tests) in normal Egyptian children, aiming at establishment of a normative values of Dichotic digits and Dichotic rhyme tests in Arabic speaking children in different age groups (6-12years old) (Tawfik et al., 2009) developed computer- based Arabic auditory training program for children with central auditory processing disorders through enhancing the cognitive- communicative abilities.

Awareness of CAPD among other professionals was also achieved through different research studies, workshops and conferences. CAPD in Egypt has passed through a long way, yet there is a need to encourage more audiologists to introduce CAPD evaluation in their clinical practice and improve media awareness of this problem (Tawfik, 2009).

The selected two aspects of APD by the current study to be diagnosed are: listening in binaural noise and the Arabic language Phonemes identification ability. Especially, those two selected aspects of APD were selected for the Egyptian children, because the noise issue in Egypt, as environmental pollution, ranks second among environmental pollution issues according to the complaint survey (received by Egyptian Environmental Affairs Agency/EEAA) for 2006, It is considered a serious issue because of its harmful impacts on citizens and public health, In the last years, it has been noticed that noise levels in Egyptian streets are disturbingly increasing. These levels have reached unacceptable limits locally and internationally. Measurements indicate that noise levels in major squares and streets may reach approx. 75–85 dB SPL (Ali &

Tamura, 2002). Further, reduced speech-in-noise intelligibility is one of the main difficulties experienced by children with auditory processing disorder (APD) (Elgeti et al., 2008).

On the other hand, especially for the young children, the phonemes identification ability known to be an important step to a child's early reading acquisition (NICHD, 2000), further, many researchers have suggested that difficulties in phonemes awareness and phoneme manipulation skills may be the foundational cause of almost all subsequent learning disabilities (Bender & Larkin, 2003; Chard & Dickson, 1999; Kame'enui et al., 2002; Lyon & Moats, 1997. Clearly, if a child with a disability to detect and identify his language phonemes, that child will experience a significant deficit when trying to detect different sounds that are represented by different letters. Difficulty in such letter interpretation can result in significant subsequent reading disabilities.

1.5. Summary and Rationale

At present, several researchers have been able to replicate findings that Auditory processing disorder is a relatively recent construct, and its diagnosis remain contentious issues (Bellis & Anzalone, 2008; Kiese-Himmel, 2008; Jutras et al., 2007). However, auditory processing disorder could be operationally defined as difficulties in perceptual processing of auditory information in central nervous system that appear only when there is a functional defection in auditory nervous system and not in another position and without the existence of any mental and nervous diseases that are represented in oblivious shortage in auditory processing skills: voice position, auditory discrimination, perception and recognition of auditory model, in addition to temporal aspects of auditory process involving temporal resolution, temporal sequencing, temporal integration, temporal interaction (Bellis, 2002; Jerger & Musiek, 2000; Watson & Kidd, 2002; & ASHA, 2005).

The APD are characterized by: Behaving as if peripheral hearing loss was present, despite normal-hearing; difficulty with auditory discrimination expressed as diminished ability to discriminate among speech sounds (phonemes); deficiencies in remembering phonemes and manipulating them (e.g. in tasks related to reading and spelling, and phonics, as well as phonemic synthesis or analysis); difficulty understanding speech in the presence of background noise; difficulty with auditory memory, either span or sequence; unable to remember auditory information or follow multiple instructions; demonstrates scatter across subtests with domains assessed by speech-language and psycho-educational tests, with weakness in auditory-dependent areas; Poor listening skills characterized by decreased attention for auditory information; distractible, or restless in listening situations; Inconsistent responses to auditory information (sometimes responds appropriately, sometimes not) or inconsistent auditory awareness (one-to-one conversation is better than in a group); Receptive and/or expressive language disorder may have a discrepancy between expressive and receptive language skills; Difficulty understanding rapid speech or persons with an unfamiliar dialect; Poor musical abilities, does not recognize sound patterns or rhythms; poor vocal prosody in speech production (Chermak & Musiek, 1997; Bamiou & Luxon, 2008; Cacaca & Mcfarland, 1998; Katz, 1962; Jerger & Musiek, 2000; Demanez, L., 2004; Musiek, 2004; Rosenberg, 2002; Chermak, 1998).

Familiarity with the anatomy and physiology of the central auditory nervous system is critical for appropriate assessment of central auditory processing; the effect of pathological conditions upon auditory processing depends on the level of the CANS affected and the extent of the lesion. Whilst, the applicability of the only two theoretical models of APD: Buffalo Model categories & Bellis/Ferre Model were examined to clinical practice and the results shown neither of these models was based on data from peer-reviewed sources (Jutras, 2007).

The etiology of APD includes prematurity and low birth weight, genetic histories, head trauma, diseases of the CANS, exposure to lead or carbon monoxide, and other medical diseases like: Landau-Kleffner syndrome, epilepsy, metabolic disorders, cerebrevascular disorders, Lyme disease, and pervasive development disorder (Bloom, 1998; Musiek et al., 1994; Huggoson et al.,1997; Davis et al., 2001; Ponton, 1999; Baran et al., 1999; Musiek et al., 1990; Chermak et al., 1999; Oliver, 1990; Keith & Pensak, 1991; Benavidez et al., 1999; Musiek & Lee, 1999; Counter et al., 1998; Setzen et al., 1999; Oka et al., 1996; Cranford et al., 1996).

The main criteria of the APD diagnostic tests are: An APD should not be a result of peripheral hearing loss; An APD should not result from a supra-modal cognitive function like language; The deficit should be specific to the auditory modality, Further the main three methods to diagnose auditory processing disorders are: Screening for Auditory Processing Disorders (APD); Differential Diagnosis of Auditory Processing Disorders (APD); Minimal Test Battery of Auditory Processing Disorders (APD), (Katz & Wilde, 1994; Marriage et al., 2001; Musiek, 2004; Sockalingam et al., 2004; Cameron, & Dillon, 2005; Coninx, 2006).

There are five basic categories that are considered vital in CAP evaluation: temporal resolution; temporal sequencing; binaural integration; binaural interaction; evaluation of overall listening performance. In addition, the APD behavioral tests classification: Measures of detection (e .g., the pure-tone audiogram and temporal integration tasks); Measures of supra threshold discrimination (e .g., difference limens for frequency, intensity, and/or duration; temporal ordering/ sequencing tasks; temporal resolution tasks; backward/forward masking tasks; masking level difference[MLD]; sound lateralization; and spatial localization); and Measures of identification (e .g. the recognition of phonemes, syllables, words, phrases, and sentences) (Cameron, 2005; Jerger & Musiek, 2000):

Egypt has a very serious noise problem, noise levels in the Egyptian streets are disturbingly increasing. These levels have reached unacceptable limits locally and internationally. Measurements indicate that noise levels in major squares and streets may reach approx. 75–85 dB SPL, and because of the reduced speech-in-noise intelligibility is one of the main difficulties experienced by children with auditory processing disorder (APD) (Ali & Tamura, 2002; Elgeti et al., 2008). The current study has selected the listening speech in binaural noise to be diagnosed as a first disorder in the Egyptian children.

Further, because of the high importance of the phonemes identification ability to a child's early reading acquisition (NICHD, 2000), and as many researchers have suggested that difficulties in phonemes awareness and phoneme manipulation skills may be the foundational cause of almost all subsequent learning disabilities (Bender & Larkin, 2003; Chard & Dickson, 1999; Kame'enui et al., 2002; Lyon & Moats, 1997), the phoneme identification ability was selected as the second disorder to be diagnosed in the Egyptian children.

1.6. The Study Questions:

Indeed, it is proved from the literature and previous studies why listening speech in binaural noise and phonemes identification ability were chosen to be screened by the current study, hence, the aims of the study are constructing and norming:

- An Arabic version of adaptive auditory speech test (AAST) in quiet to rule out the peripheral auditory involvement by screening the children for any hearing loss in dB SPL units.
- An Arabic version of adaptive auditory speech test (AAST) in binaural noise for screening the first selected APD aspect: listening speech in binaural noise.
- Teetaatoo tests for the Arabic phonemes identifications.

Participants included children between the ages of 5 to 7 years old from the nursery school children. The main question of the study is:

How the two selected APD (listening speech in binaural noise and the phonemes identification ability disorders could be screened in the Egyptian children at risk for learning disability aged from 5 to 7 years old?

And to answer this question, the following sub-questions should be answered:

1. What are the norms of AAST in Quiet (peripheral hearing threshold) for the Egyptian children aged from 5 to 7 years old?
2. What are the norms of AAST in binaural noise for the Egyptian children aged from 5 to 7 years old?
3. What are the norms of the ''teetaatoo''test for Egyptian children aged from 5 to 7 years old? And this question could be divided to five sub questions according the phonemes sub categories:
   - 3.1. What are the norms of the Cons-A sub test (easy set for all the consonants)?
   - 3.2. What are the norms of the Cons-B1 sub test (for: plosives identification)?
   - 3.3. What are the norms of the Cons-B2 (for: nasals, trill, approximant and lateral identification)?
   - 3.4. What are the norms of the Cons-B3 (for: fricatives identification)?
   - 3.5. What are the Norms of the Vow-A (easy set for vowels identification)?
4. Do the scores of the abnormal cases on the Arabic AAST in binaural-noise and the five subtests in teetaatoo test matches their SIFTER data analysis?

2. Chapter II: Methods

3.1. Participants

Participants included children between the ages of 5 to 7 years old from the nursery school children in Beni-Suef town in Egypt. The participants of this study come through three stages:

The first stage:

The pre-experimental testing included 40 children between the ages 5 to 7 years old, (30 children for testing the internal balancing of the Arabic AAST in quiet and in binaural noise), (10 children for testing the learning effect and the reliability).

The second stage:

The aim of this stage is screening children in the nursery school for calculating the standard scores (Norms) of the Speech Recognition Threshold (SRT) using the Arabic AAST in Quiet, 338 children with mean age 6.08 with Standard Deviation 0.8.

The third stage:

According to the calculated Norms of the AAST in quiet in the previous step and through a meeting with the teachers of the children in the nursery school, 129 children were sift out with no hearing loss, negative histories of neurological disorders, head trauma or surgery, dizziness, and attention deficit disorder/attention deficit hyperactivity disorder.

129 children were screened for the listening in binaural noise using the Arabic AAST in binaural noise, then the left 94 children, because 35 children couldn’t complete the testing, were screened for phonemes identification ability using teetaatoo test (the five sub tests).

3.2. Instrumentation

3.2.1. AAST_ Adaptive Auditory Speech Test.

The Adaptive Auditory Speech Test (AAST) assesses the Speech Recognition Threshold (SRT) under quiet and noisy conditions. Actually it was designed especially for young children starting from 3-4years old, but it can be used for adults as well. The procedure is minimally dependant on the person's vocabulary. Only 6 easy words are used and the test subject has to point to a picture to identify the word. The test is already established in many languages. In German, Dutch, and English, for example, the test uses spondee words (such as airplane, toothbrush, football etc.) or tri-syllable words in case of spondee words absence in a particular language because both of them have a redundancy comparable with short everyday sentences (Coninx et al., 2009).

There are many areas for AAST application: quick measurement of speech recognition threshold; measurement of minimal and unilateral disorders in kindergarten; verification of aided thresholds with hearing aids and/ or cochlear implants; CAPD-Screening using binaural speech-in-noise-tests (Coninx, 2006) but the current study has developed the Arabic version of AAST and used it as:

- Quick measurement of speech recognition threshold in dB SPL units (AAST in quiet);
- CAPD- Screening (AAST in binaural noisy condition).

The Arabic AAST Features:

- Quick measurement of the SRT with children from 3-4 years old. It lasts for 2 minutes.
- Tri-syllable words feature higher redundancy, compared to monosyllabic or disyllable words.

- AAST is a closed testing procedure. The testee sees six pictures. One of the test words is uttered, and the testee tries to identify it by pointing at one from the six pictures, The program stops automatically after seven wrong answers; the examining person can also abort it by clicking the 'Stop'' button. Figure (4) provides Graphical Interface of the Arabic AAST.
- The presentation of the stimuli, the processing of the testee's responses and the analysis are carried out by the AAST program.
- After every correct answer, the next word is presented with 5 dB SPL lower volume (with speech in noise: 3 dB SPL). After every wrong answer, the volume is turned up by 10 dB SPL (with speech in noise: 6 dB SPL). This up-down-method adapts the presented stimuli to the speech recognition threshold in a quick and efficient manner, figure (5) displays the Audiogram proceeding.

Figure 4. Graphical interface of the Arabic AAST.

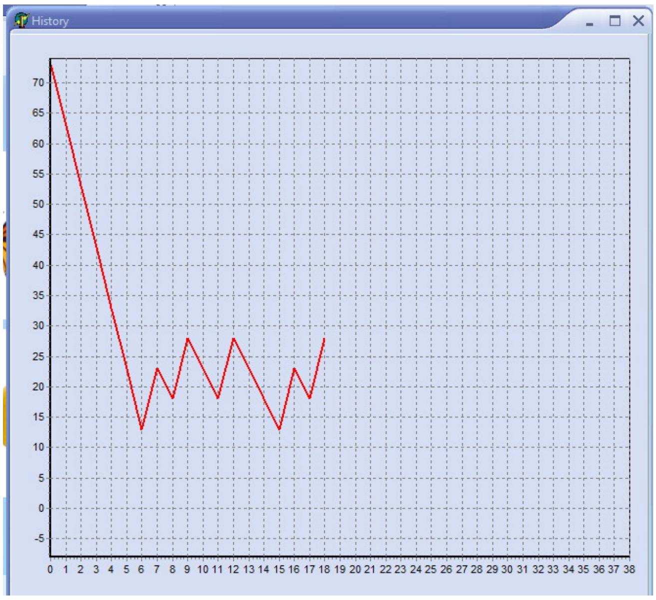


Figure 5. AAST audiogram proceeding.

The Arabic Version of AAST Preparation Procedures:

Selecting the words

Basically, the Speech Auditory Test for Hearing Assessment should contain Spondee words like: airplane, football, snowman, cowboy …etc. (Bess & Humes, 1995, 3-5). But as there is no such like this type of words in the Arabic Language, the other possibility is using 3-syllable words which with a similar level of redundancy as compared to spondee words. Rather, the 6 words should meet the following criteria, (Coninx, 2006):

- 3-4 years old children know the meaning of the words
- 3-4 years old children recognise a picture of the words
- The words do have the same prosodic pattern (number of syllables and stressed syllable): S-S (spondee), S-W-W (trisyllable, first syllable stressed) or W-S-W (trisyllable, second syllable stressed), whereas S=strong, W=weak.
- The words are maximally different at the phoneme level. Preferably the phoneme statistics should correspond to the frequency of occurrence in the particular language, parentheses passed on phoneme groups.

Output

In the beginning, Over 25 tri syllable words matching the above criteria except the fourth criterion (corresponds to the frequency of occurrence in the Arabic language) were selected. It means that the selected words still should be maximally different at the phoneme level; in other words, the phonemes of the selected six words should match the general distribution of consonants and vowels in the Modern Standard Arabic (MSA) language.

Watson, (2002) & Thelwall, (1990), denote to the Standard Arabic Consonant phonemes (Appendix A), and to the general distribution of the Consonants over the MSA, (Appendix B). The current study has developed the distribution curve of the Consonants in MSA (figure 6) based on the data which was in Appendix A and B.

The Vowels distribution curve of MSA wasn't found, hence, this Study had to develop it by screening the vowels in an ordinary Arabic article (Appendix C) published in a daily newspaper in Egypt. Figure 8 displays the vowels distribution curve of the MSA.

The phonetic transcription of the selected six tri syllable words, clarifying the number of every consonant and every vowel in each selected word (table 4), is written down, and by comparing the distribution of vowels and consonants in the 6 words to the original distribution curves of vowels and consonants in MSA, the selected 6 tri-syllable words (table 3) have the closest Consonant and vowels distribution (figure 7, 9) to the original distribution of consonants and vowels in MSA

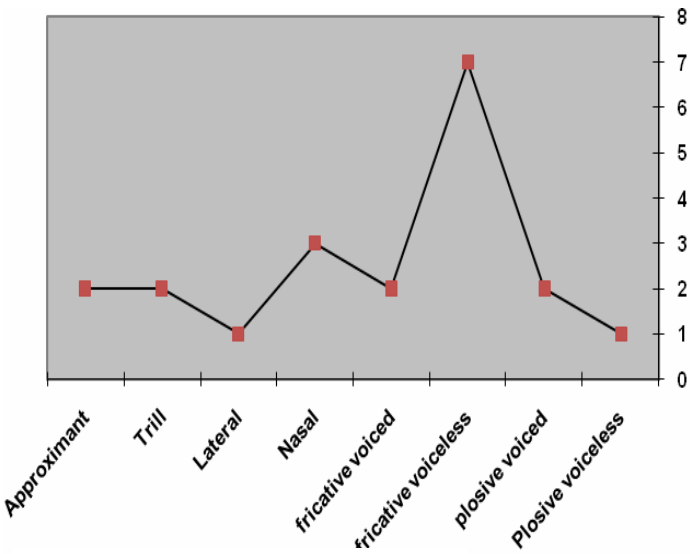


Figure 7.

The Frequency Occurrence of consonants in the selected six words

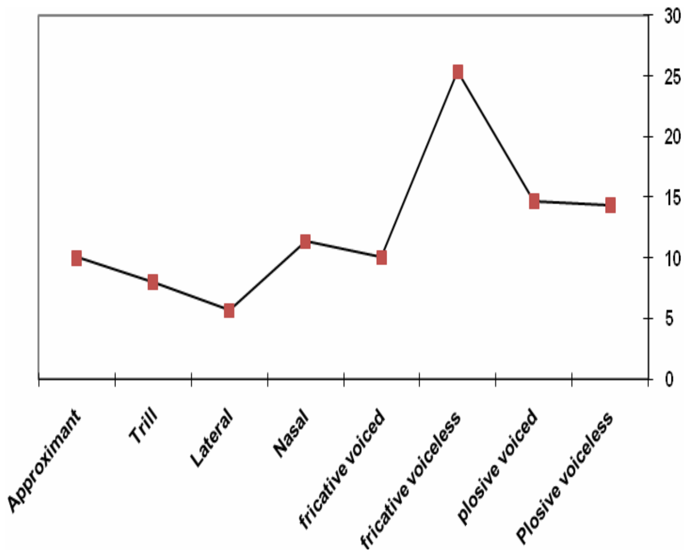


Figure 6.

The Frequency Occurrence of consonants in the MSA language

Table 3.

The Selected Six Tri-syllable Words of the Arabic AAST

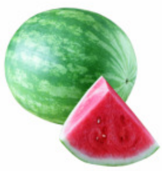
The Arabic word	The English translation	The phonetic transcription	Prosodic pattern	First proposal for a picture
تفاحة	Apple	tufa:ħa	W-S-W	
فراشة	Butterfly	farɑ:sha	W-S-W	
زرافة	Giraffe	zarɑ:fa	W-S-W	
ليمونة	Lemon	laimu:na	W-S-W	
سفينة	Ship	sifi:na	W-S-W	
بطيخة	Watermelon	bati:xa	W-S-W	

Table 4.

The Distribution of Consonants and Vowels Numbers in the Selected Six Words

Consonants	Tufa:ħa	Farɑ:sha	Zarɑ:fa	Laimu:na	Sifi:na	Bati:xa	Total
Plosive voiceless						1	1
plosive voiced	1					1	2
fricative voiceless	1	2	1		2	1	7
fricative voiced	1		1				2
Nasal				2	1		3
Lateral				1			1
Trill		1	1				2
Approximant				1		1	2
Vowel							
/a/	1	2	2	1	1	2	9
/a:/	1	1	1				3
/i/					1		1
/i:/					1	1	2
/u/	1						1
/u:/				1			1
Ai				1			

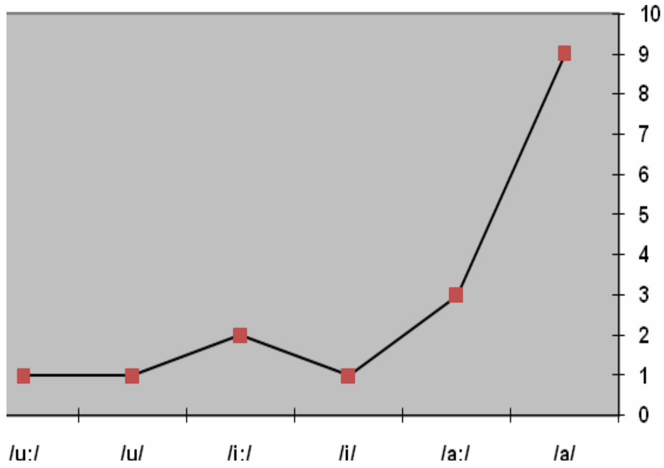


Figure 9.

The Frequency Occurrence of consonants in the selected six words

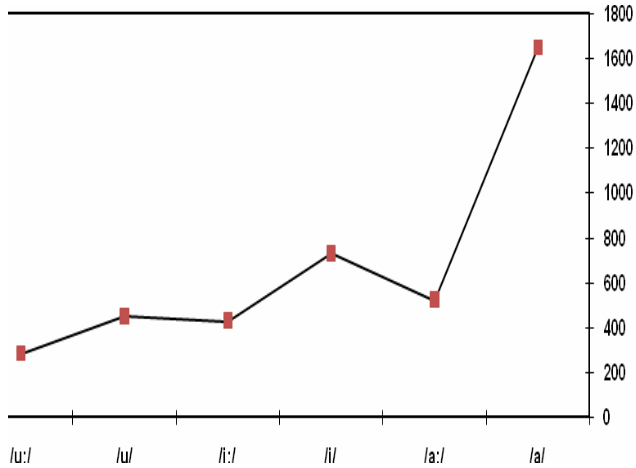


Figure 8.

The Frequency Occurrence of consonants in the MSA language

Recording the sound files of the words and the noise files

Recording the six selected words using a female speaker with clear but natural pronunciation and an as widely as possible acceptable accent were taken place in IfAP – (Institut für Audiopädagogik) at university of Cologne. Actually, the study chose the female voice, because a female voice is closer to the middle of the children hearing range and more soothing, (Klatt & Klatt, 1990). In other words, a typical female voice has a moderate fundamental frequency F0 of about 220 Hz which lies between the typical male voices with a pitch of about 120 cycles per second or 120 Hz, and the baby's voice which has a F0 of about 400 Hz.

The sound files are recorded using a high-quality microphone; digital recording equipment in a professional recording room (no reverberation, minimal ambient noise) as mono (one microphone, one channel), sound digitized at 44.1 kHz and 24 bits, PCM... wav-file), In order to prepare the noise files, a speech material of the same speaker is recorded for 2 min, while she was reading aloud a text from a book.

Output

Six sound files for the six words have a quiet close energy (total power) to each other as shown in table (5), and at maximum sound pressure level (SPL) without any distortion as shown by the six displayed voice spectra pictures, figures (10-15).

Table 5.

The Average and the Total Power of the Six Words.

The Word	Average power	Total Power
Apple	-17.5	-16.0
Butterfly	-17.9	-16.1
Giraffe	-18.2	-16.0
Limon	-13.4	-12.5
Ship	-15.1	-13.0
Watermelon	-18.9	-17.4

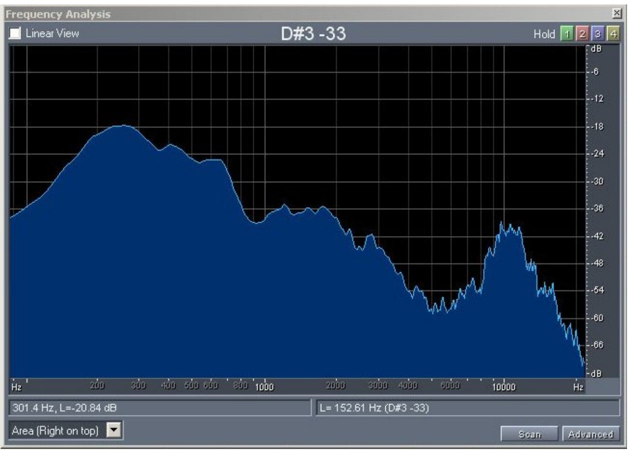


Figure10. Voice Spectrum of Apple

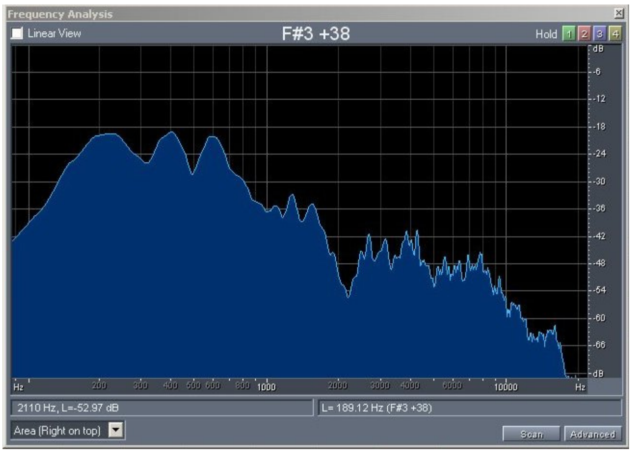


Figure 11. Voice Spectrum of Butterfly

Figure 12. Voice Spectrum of Giraffe

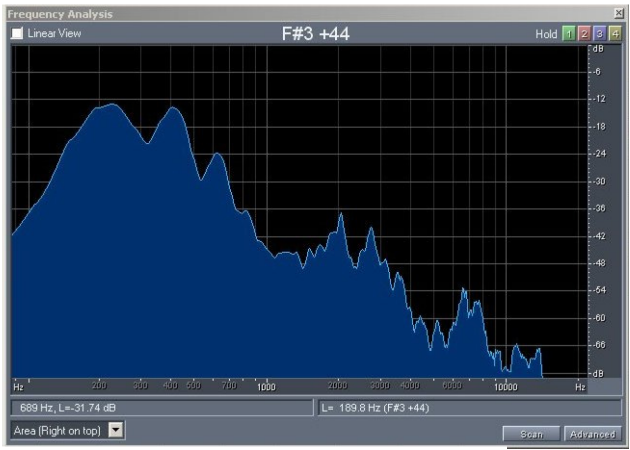


Figure 13. Voice Spectrum of Limon

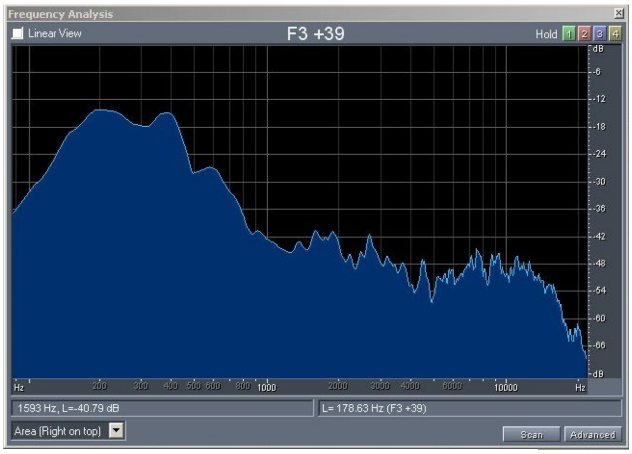


Figure 14. Voice Spectrum of Ship

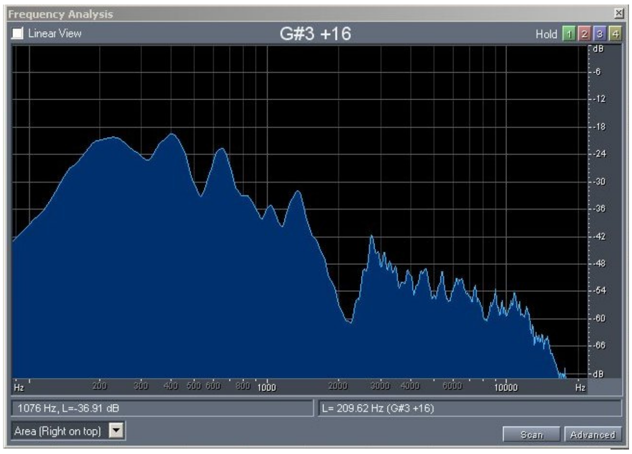


Figure15. Voice Spectrum of Watermelon

Selecting the Pictures of the selected six words

Using a web site for photo collections www.istockphoto.com , the study has selected and has bought the six pictures of the six words with definite properties to suit the test software (table 6).

Table 6.

Properties of the Six Photos in the Arabic AAST.

The word	Picture No	Size	Pixels	File size
Apple	2772899	Small	849*565	252.54 KB
Butterfly	8434594	Small	827*528	304.71 KB
Giraffe	3142360	Small	693*693	180.51 KB
Limon	2084296	Small	849*565	341.68 KB
Ship	2218144	Small	849*565	569.37 KB
Watermelon	6474336	Small	738*650	263.04 KB

For checking that children aged 4 years can recognize the six pictures successfully 30 children aged 4 years were tested by showing them the six pictures and asking every child about the name of each picture**,** and all the 30 children succeeded in recognizing the pictures.

Preparation of the final stimulus contents of the Arabic AAST

Psychometric curves for checking the internal balancing of the six words

The psychometric curve shows the intelligibility of the word perception, if he might/might not prefer to recognize a definite word more than the others. It is a relation between the intensity sound level in dB SPL unit on the horizontal axe against the percentage of the children correct answers on the vertical axe.

Actually, 30 normal children were tested by running AAST in Quiet and in binaural noise on every child and collecting data. The percentage of the correct answers for each word against a relative intensity sound level in dB SPL plotted for checking the internal balancing of the picturable six words. Table 7 and figure 15 display the extracted data and psychometric curves for The Arabic AAST in Quiet which clarify that the intelligibility degree of the 6 words are quite close, while Table 8 and Figure 16 display the extracted data and psychometric curves for the Arabic AAST in binaural noise which clarify that the intelligibility degree of the 6 words in binaural noise condition are also quite close.

Table 7.

The Percentage of the Children Correct Answers on Each Word in the Quiet AAST against the Relative Sound Intensity Level in dB SPL.

sound intensity level in dB SPL	The percentage of the children correct answers					
	Appel	Butterfly	Giraff	Lemon	Ship	Watermelon
10	0	6,25	16,66	5,88	0	16,6
15	16,27	16,31	21,87	46,15	7,89	29,27
20	51,31	58,14	73,58	78,46	36,06	74,32
25	85,71	84,44	92,31	92,72	88,88	95
30	100	90,47	96	97,56	88,57	97,56

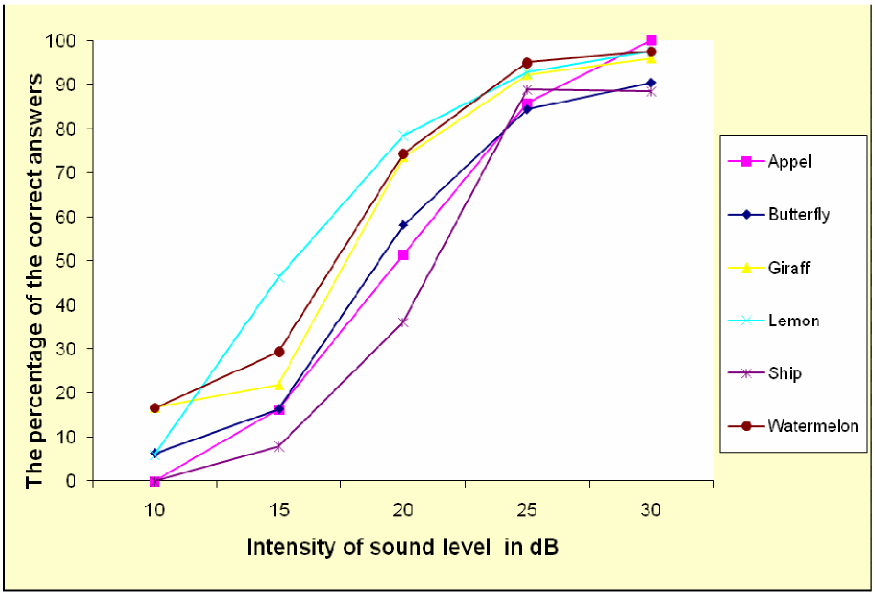


Figure16. Psychometric curves of the six words in the Arabic AAST in quiet

Table 8.

The Percentage of the Children Correct Answers on Each Word in the AAST in Binaural Noise against the Relative Sound Intensity Level in dB SPL.

sound intensity level in dB SPL	The percentage of the children correct answers					
	Apple	Butterfly	Giraffe	Lemon	Ship	Watermelon
35	16,6	13,11	0	0	10,4	0
40	56	50	32,14	25	24	33,72
45	58,44	54,16	54,16	84,6	85,7	59,88
50	85,33	92	84,2	100	100	87,55
55	95,43	100	100	100	92,3	100

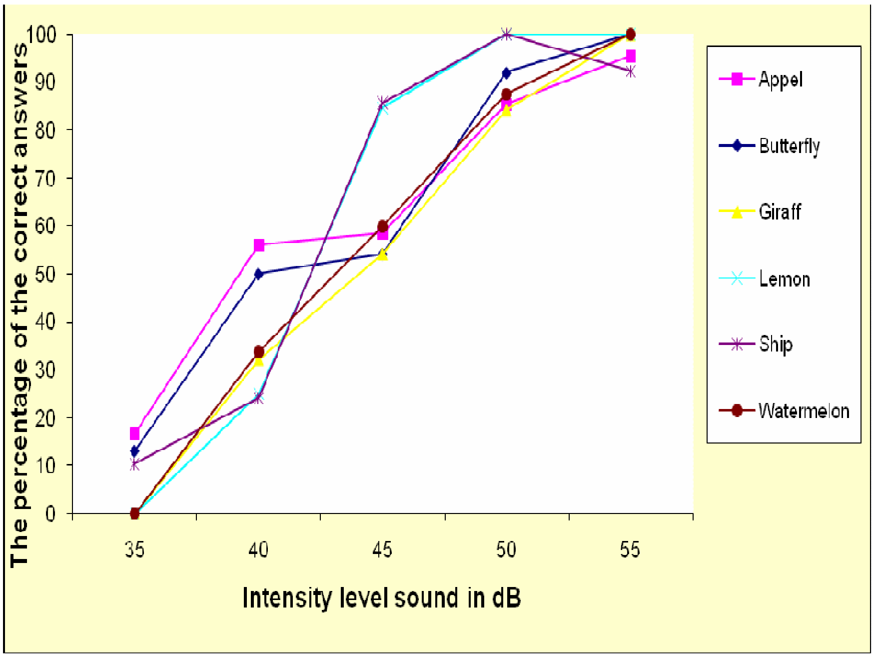


Figure17. Psychometric curves of the six words in the Arabic AAST in bin-noise

Learning Effect

Because of the easy closed set paradigm with picture pointing as a response task for the children, the introduction time is short and the learning effects correspondingly fast and small (Fels et al., 2009). However, the current study has tested the learning effect on the Arabic AAST by running both of AAST in Quiet and AAST in Binaural noise on a group of 10 children three times to check the if there is learning effect or not.

Mean and standard deviations for both of AAST in Quiet and AAST in Binaural noise as a function of conducting times are provided in Table 9. For checking the learning effect, two One-way ANOVAs (SPSS 12.0 SPSS Inc) were conducted to examine differences in mean SRT (dB SPL) in Quiet and in Bin-noise conditions as a Function of Conducting Times. The summaries of the ANOVAs are in Table 10. As seen in table 10, there is no significant difference in the Peripheral Hearing Threshold (dB SPL) Mean between the three conducting times on the children group (N=10), which means that there is no learning effect on Arabic AAST in quiet and in Bin-noise.

Table 9.

Means and Standard Deviations for Both of AAST in Quiet and AAST in Binaural Noise as a Function of Conducting Times, whereas (N= 10).

	Conducting Times		
AAST in Quiet	1st	2nd	3rd
Mean	14,17	14,76	12,42
S	3,43	4,10	3,15
AAST in Bin-noise	1st	2nd	3rd
Mean	-10,75	-11,8	-11,95
S	1,53	2,02	1,99

Table 10.

Summary Table for the Two Times One-Way ANOVAs Investigating Differences in Mean SRT (dB SPL) in Quiet and in Bin-noise Conditions as a Function of Conducting Times, whereas (N=10).

AAST in Quiet	*Df*	F	Sig.
Between groups	2	1,155	0,33
Within groups	27		
AAST in Bin-noise	*Df*	F	Sig.
Between groups	2	1,235	0,307
Within groups	27		

AAST Reliability:

For assessing the reliability of the Arabic AAST, a children group (N= 30) was tested for two times with three weeks in between as an interval time, and the statistical significance of the means differences between the two times for AAST in quiet and in binaural noise were calculated by comparing the means in each with independent-samples t-test (SPSS version 12). As seen in table 11, there is no significant difference in mean speech recognition threshold (dB SPL) for AAST in quiet between the two times, and in mean binaural speech listening in bin-noise threshold (dB SNR), which means that the Arabic AAST in the two conditions (quiet and noise) are reliable.

Table 11.

Summary Table for Independent-Samples T-Test Investigating Differences Significance in Mean SRT (dB SPL) for AAST in Quiet and in Mean Binaural Speech Listening in Binaural Noise Threshold (dB SNR) as a Function of Conducting Replication.

AAST in Quiet	*Mean*	*S*	T-Value	Sig.
1st Conducting Time	26,55	4,49	0,174	0,862
2nd Conducting Time	26,63	4,12		
AAST in Bin-noise	***Mean***	***S***	**T-Value**	**Sig.**
1st Conducting Time	-11,73	2	0,036	0,971
2nd Conducting Time	-11,75	27		

Table 12. The Arabic AAST Protocol Summary

	Tri-syllable Left	Tri-syllable Right	Tri-syllable In Bin-noise
Objective	SRT in silence	SRT in silence	SRT in binaural noise
Art	Interactive test by Pc		
Materials	1. AAST Software 2. external Soundkcard (M-Audio Transit; USB) 3. Headphone HD 280 pro.		
Stop automatically after…	7 mistakes	7 mistakes	7 mistakes
Step if correct	5dB SPL lower	5dB SPL lower	3dB SPL lower
Step if wrong	10 dB SPL higher	10 dB SPL higher	6dB SPL higher
Step until first mistake	10 dB SPL lower	10 dB SPL lower	6dB SPL lower
Seating arrangement	The child sits on his chair comfortably in front of the PC and the conductor beside him.		
Initiation	1. open the AAST, and fill in the child´s data as a case, then let the child wear the headphone. 2. Be sure that the headphone is covering the intended child ear (the left or the right one). 3. Be sure that the child recognizes all the six pictures successfully by asking him about the name of each,and in case of Conducting the test on many children, explain words in the classroom, otherwise you can let the teacher do it, the last procedure to not loose too much time for each child all the time again. 4. Then tell him that now he will hear the name of each photo, and he should point to the photo by his finger as soon as he hears its name. 5. Try to train the child before the real examining by conducting the first time as an exercise. And in case of any latency in the child response he should be excluded as a case.		
The conducting	1. The child should listen well to which word the computer "says", then he should point at the photo of the heard word, then the conductor can click it. 2. After clicking the picture of the heard word, the next word comes immediately and the child should be alerted enough and not distracted.		
Time	Duration 2 Minute		Software Analyze 0 Minute
Data Storage	The results are saved automatically on the PC.		

3.2.2. "teetaatoo'' Word free test for auditory phonemes identification:

"teetaatoo" is a word free test for measuring the auditory ability of the child to identify the different Arabic language Phonemes. There is no isolated phonemes are used, but mini -syllables in two sets:

- C-set contains different consonants followed by the same vowel. For instance ba, sa, and da.
- V-set contains the same consonant followed by different vowels. For instance ti, ta, and tu.

Contents:

The Arabic version of '' teetaatoo'' test contains five subtests:

i. Cons-A or the easy and the various consonants set, which contains most of the Arabic consonants subcategories phonemes presented in six mini-syllables (6 elements) (/k/a, /w/a, /d/a, /ʃ/a, /m/a, and /x/a).
ii. Cons-B1 contains only the plosives phonemes presented in four elements (/b/a, /d/a, /k/a, and /t/a).
iii. Cons-B2 contains all the Arabic consonants subcategories phonemes except Plosives and Fricatives which are presented in six elements (/j/a, /w/a, /m/a, /n/a, /l ˀ/a, and /r/a).
iv. Cons-B3 contains only the fricatives phonemes presented in six elements (/f/a, /ʃ/a, /x/a, /θ/a, /s/a, and /ħ/a).
v. Vow-A is the only V-set for identifying the different Arabic Vowels which contains five elements; the long forms of the three Arabic vowels (t/a:/, t/i:/, and t/u:/) and two diphthongs(t/aj/ and t/aw/).

An overview:

These five auditory subtests are designed for children aged 4 years old and provided with an Introductory set for training the child before starting the real test. When the test starts, a window full of yellow cells is opened, and in somewhere in the page, there is a red cell surrounded by blue cells(look at figure 18), the conductor should click the red one and let the child hear the spoken mini-syllable, and if the child asked to repeat it, the conductor can click it again, then the conductor clicks on the blue cells one by one, asking the child in the mean time which one of those are similar to the red one, and the child can point at the right blue cell.

Regardless of whether the child response was right or wrong, the conductor should continue and the software is calculating the right and the wrong answer automatically.

During the working on the teetaatoo subtests, a popular photo in the behind is appearing as a background step by step as shown in figure 18 , which makes the working on that test exciting and interesting, and in the end of the test the whole photo will appear as shown in figure 19.

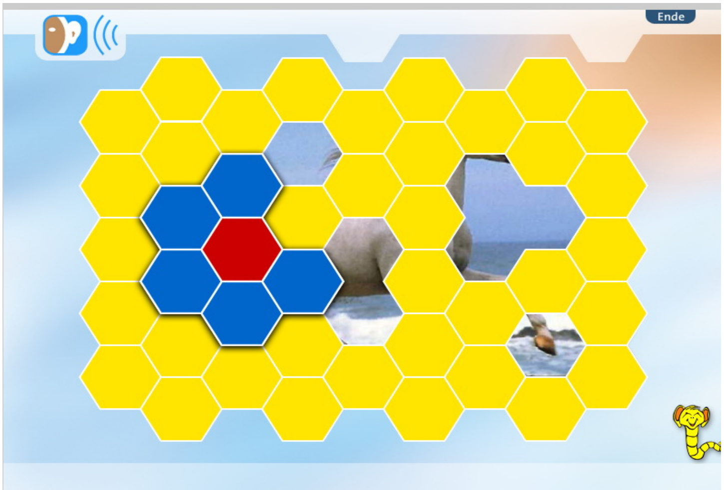


Figure 18. Graphical interface for the teetaatoo

Figure 19. An example of an appeared photo in the end of a subtest

(teetaatoo) Preparation Procedures (Coninx, 2005):

1. All the Arabic language phonemes are listed and written in International Phonetic Alphabet (IPA) symbols (Watson, 2002; Thelwall, 1990).
2. All the phonemes were grouped into consonants and vowels.
3. All the phonemes were prepared:
    - In a C-set contains the same vowel (Matching the possible different consonant against the same vowel).
    - In a V-set contains the same consonant (Matching the possible different vowel against the same consonant).
4. The consonants phonemes were classified into three groups which will be the three difficult auditory subtests for assessing the consonants identification ability:
    - Cons- B1: Plosives.
    - Cons-B2: Others (nasals, trills, approximants and laterals)
    - Cons-B3: Fricatives.
5. For developing the easy consonants set (Cons-A), 2 consonants were picked from each group (Cons-B1, Cons-B2, Cons-B3).
6. There are only six vowels and two diphthongs (eight elements in total) in the Arabic language. Hence, it was difficult to construct two groups with a big difference in between, and only an easy set Vow-A was prepared contains the long forms of the three Arabic vowels (t/a:/, t/i:/, and t/u:/) and two diphthongs(t/aj/ and t/aw/).
7. The sound files recording of all the five sub tests (Cons-A, Cons- B1, Cons-B2, Cons-B3, Vow-A) were completed under the same acoustic conditions of the AAST.
8. The Loudness balancing: the loudness of all the recorded mini-syllables was controlled subjectively. Also, five persons were involved to judge the loudness balances again, and all of them have become quite close to each other.
9. The number of elements in each set should be 6; sometimes also it could be from 4 to 8.

10. Five popular pictures to the Egyptian children were chosen as a background for each sub-test and to be like a reward in the end of each sub-test.

Preparation of the final stimulus contents of the teetaatoo test:

A confusion matrix is a visualization tool. It is typically called a matching matrix. Each row of the matrix represents the child responses, while each column represents the actual software stimulus. One benefit of a confusion matrix is that it is easy to see if the system is confusing two phonemes (i.e. commonly mislabeling one as another).

When a data set is unbalanced (when the number of responses in different classes vary greatly) the error rate of a stimulus is not representative of the true performance of the stimulus.

1. Cons-A Confusion Matrix:

As seen in the first Auditory sub test (Cons-A) confusion matrix below, table 13, of the 163 actual /d/a, the system responded that 8 were /k/a, 0 was /x/a, 3 were /m/a, 2 were /ʃ/a, and 4 were /w/a. and all of the previous mistakes could be considered subjectively very small comparing to 146 right /d/a responses, hence, it is clear that there is no confusion between /d/a phoneme from one side as a stimulus, and the other five phonemes in Cons-A set as responses. Also, there is no confusion between /k/a phoneme from one side as a stimulus, and the another five phonemes in Cons-A set as responses, the same thing with the other phonemes as stimuli and their responses, there is no confusion between each of them.

Table 13.

Cons-A Confusion Matrix

		Stimulus					
		/d/a	/k/a	/x/a	/m/a	/ʃ/a	/w/a
Response	/d/a	146	14	8	1	4	0
	/k/a	8	132	4	3	0	0
	/x/a	0	7	144	2	9	1
	/m/a	3	0	2	156	1	2
	/ʃ/a	2	8	0	0	146	3
	/w/a	4	0	3	0	1	156
	Total	163	161	161	162	161	162
	No of errors	90					

2. Cons-B1 Confusion Matrix:

The confusion matrix of Cons-B1 in table 14, shows minimal confusion between phonemes stimuli and phonemes responses, which is acceptable because all of the tested phonemes are plosives.

Table 14.

Cons-B1 Confusion Matrix

		Stimulus			
		/b/a	/d/a	/k/a	/t/a
Response	/b/a	273	48	2	6
	/d/a	37	230	19	47
	/k/a	6	8	267	37
	/t/a	10	39	37	235
	total	326	325	325	325
	NO of errors		296		

3. Cons-B2 Confusion Matrix:

The confusion matrix of Cons-B2 in table 15, shows no confusion between phonemes (stimuli) and phonemes (responses), except acceptable confusion between /m/a as a stimulus and /n/a as a response because both of them are nasal phonemes, and there should be the same degree of confusion in the opposite case (/n/a as a stimulus and /m/a as a response) but it was a technical programming mistake, which is clear as 0 responses in the second row and the third column in table 15.

Table 15.

Cons-B2 Confusion Matrix

		Stimulus					
		/l^2/a	/m/a	/n/a	/r/a	/w/a	/j/a
Response	/l^2/a	186	0	6	4	4	9
	/m/a	5	161	0	2	3	3
	/n/a	8	51	199	0	1	0
	/r/a	13	3	5	196	0	8
	/w/a	4	0	4	3	202	1
	/j/a	0	1	2	10	5	195
	Total	216	216	216	215	215	216
	No of errors	155					

4. Cons-B3 Confusion Matrix:

The confusion matrix of Cons-B3 in table 16, shows minimal confusion between phonemes stimuli and phonemes responses which is acceptable, because all of the tested phonemes are fricatives.

Table 16.

Cons-B3 Confusion Matrix

		Stimulus					
		/f/a	/ħ/a	/x/a	/s/a	/ʃ/a	/θ/a
Response	/f/a	178	1	0	10	10	106
	/ħ/a	1	209	5	1	1	0
	/x/a	17	1	193	0	1	9
	/s/a	16	3	5	143	0	16
	/ʃ/a	6	0	1	17	192	4
	/θ/a	0	4	14	47	14	83
	Total	218	218	218	218	218	218
	No of errors	310					

5. Vow-A Confusion Matrix:

The confusion matrix of Vow-A in table 17, shows no confusion between vowels (stimuli) and vowels (responses), because it is an easy vowels set.

Table 17.

Vow-A Confusion Matrix

		Stimulus				
		t/a:/	t/aj/	t/aw/	t/i:/	t/u:/
Response	t/a:/	197	9	4	1	3
	t/aj/	7	198	2	5	3
	t/aw/	3	4	203	1	2
	t/i:/	6	3	2	207	3
	t/u:/	3	2	5	2	205
	Total	216	216	216	216	216
	No of errors			70		

Reliability of teetaatoo subtests:

For assessing the reliability of the teetaatoo subtests, 30 children were tested for two times with three weeks in between as an interval time, and the statistical significance of the means differences between the two times for each subtest were calculated by comparing the means in each with independent-samples t-test (SPSS version 12). As shown in table 18, there is no significant difference for any of the five subtests, which means that all the five subtests of teetaatoo test are reliable.

Table 18.

Summary Table of Independent-Samples T-Test Investigating Differences Significance between the Two Conducting Times for Each Test.

	Conducting time	Mean	S	T-Value	Sig.
Cons-A					
	1st	93,61	11,92	1.09	0,280
	2nd	88,12	24,87		
Cons-B1					
	1st	81,11	12,93	0,503	0,617
	2nd	82,77	12,74		
Cons-B2					
	1st	89,72	11,92	0,294	0,770
	2nd	90,56	9,96		
Cons-B3					
	1st	76,74	13,61	0,925	0,359
	2nd	80,00	11,91		
Vow-A					
	1st	95,00	6,82	0,205	0,383
	2nd	95,33	5,71		

Table 19. The Arabic teetaatoo Protocol

	Cons-A	Con-B1	Cons-B2	Cons-B3	Vow-A
Objective	Measures the ability to identify consonant - easy level.	Measures the ability to identify plosives.	Measures the ability to identify nasal, lateral, trill and approximant.	Measures the ability to identify fricatives.	Measures the ability to identify vowels-easy level.
Art	Interactive test by Pc				
Materials	1. teetaatoo Software . 2. external Soundkcard (M-Audio Transit; USB) 3. Headphone HD 280 pro.				
Stop automatically after…	12 trials whatever right or wrong				
The Proceeding	The software goes on regardless of whether the child response was right or wrong.				
Seating arrangement	The child sits on his chair comfortably in front of the PC and the conductor beside him.				
Initiation	1. open the teetaatoo test, and fill in the child´s data as a case, then let the child wear the headphone. 2. Try to train the child before the real examining through the introductory task icon as an exercise. To see how the test proceeds.				
The conducting	1. The conductor should click the red sixfold and let the child hear the spoken mini-syllable, and the child can ask the conductor to repeat it. 2. The conductor should click on the blue sixfolds one by one, asking the child in the mean time which one of those are similar to the red one, and the child can point at the right blue sixfold. 3. Regardless of whether the child response was right or wrong, The conductor should continue and the software are calculating the right and the wrong answer automatically. 4. During the working on the teetaatoo subtests, a popular photo in the behind is appearing step by step, which makes the working on the test exciting and interesting, and in the end of the test the whole photo comes.				
Time	1. Duration About 3 min for each subtest			2. Software Analyze 0 Minute	
Data Storage	The results are saved automatically on the PC.				

3.2.3. Screening Instrument for Targeting Educational Risk (S.I.F.T.E.R), (Anderson, 1989).

SIFTER is a subjective questionnaire and a very useful functional assessment tool, the purpose of the SIFTER is to identify and track hearing impaired students who might be educationally at risk by determining functional performance in comparison to their normal hearing peers. Functional performance would be defined as behaviors that contribute to the success of a student within the mainstream classroom (Anderson 2004).

The SIFTER is an immediate, user-friendly way to collect data in a variety of skill areas identified as essential for success in the classroom. SIFTER is a series of three age-related educational screening inventories designed to indicate children with hearing loss who may be experiencing educational difficulties as a result of their hearing impairment.

SIFTER has a scoring chart (Appendix D) that helps the user compare how an individual performed in comparison to a large pool of young people with normal and impaired hearing whose teachers also completed the instrument. The SIFTER has been field tested and shown to have good content and score reliability The children responses are plotted on a chart which indicates *pass* (49-75) *marginal (38-44)* or *fail (<33)* for each of the five content areas: academics, attention, communication, class participation, and school behavior (Anderson, 1989).

Actually, it consists of 15 questions relating to a student's school performance when hearing problems are suspected. Areas covered are academics, attention, communication, class participation, and school behavior. Completion of the questionnaire provides information helpful to the nurse and audiologist in completing more through testing; helpful as a pre-test and post-test when evaluating the benefit of personal or classroom amplification; also used as an in-service instrument with teachers to discuss possible effects of hearing problems on learning. In the current study the

(SIFTER) is used in the clinical analysis for the abnormal cases which have been found out after the APD sample screening.

3.3. General Procedures

A quit room meeting standards for permissible ambient noise in a summer nursery school for the children in Beni-suef town in Egypt served as the test environment for the Arabic AAST and teetaatoo testing. All testing, including pre-experimental and experimental testing, lasted approximately four weeks, 5 hours daily and was conducted over a two-day period. Participants were given a few minutes break between experimental tasks especially in the five subtests of teetaatoo to reduce the occurrence of fatigue and inattention during testing.

After finishing the pre-experimental testing, 338 children was screened using the Arabic AAST in Quiet for calculating the Norms in order to use it in exclusion of the children with hearing loss form the ADP screening.

According to the calculated Norms of AAST in quiet in the previous step and through a meeting with the teachers of the children in the nursery school, 129 children was sift out with no hearing loss , negative histories of neurological disorders, head trauma or surgery, dizziness, and attention deficit disorder/attention deficit hyperactivity disorder.

129 children were screened for the listening in binaural noise using the Arabic AAST in binaural noise, then the left 94 children, because 35 children couldn't complete the testing, were screened for phonemes identification ability using teetaatoo test (the five sub tests).

According to the calculated norms of the AAST in bin-noise and of ''teetaatoo''test, some few poor scores were found out, then a copy of SIFTER was sent to the teachers of those children with poor scores to be filled in, finally, a clinical analysis for those children with poor scores were done using the available data from the

APD battery (AAST in bin-noise and teetaatoo test) and the SIFTER trying to diagnose if they are might be with APD.

3.4. Statistical Methods

One-Way ANOVAs, Independent-Samples T-Test, Q-Q plots, Histograms, and other statistical descriptive parameters (Mean, Median, Standard Deviation, and Pearson Coefficient Skewness) were done as statistical methods in the current study to achieve all the goals of the study.

One-way ANOVAs (SPSS-Version 12) was used for investigating differences significance in mean SRT (dB SPL) in quiet and in bin-noise conditions (dB SNR) as a function of conducting times, in order to test the reliability of the AAST in quiet, in binaural noise and to test the learning effect.

Independent-Samples T-Test (SPSS-Version 12) was used for investigating differences significance between the two conducting times for each subtest, in order to test the reliability of the teetaatoo test.

One-Way ANOVAs (SPSS-Version 12) was utilized again to examine if there are significant differences in means of each conducting test as a function of age varying from 5 to 6 to 7 years old.

Descriptive analysis of the data was done to examine the normality of the collected data by each test: Mean (M), Median, Standard Deviation (S), Pearson Coefficient Skewness (Sk), also Q-Q plot was done as an ensuring procedure for the normality of the collected data.

Microsoft Excel 2007 was used to plot all the Histograms of the five subtests of teetaatoo, to calculate the standard scores (Norms).

4. Chapter III: Results

Diagnosing auditory processing disorder is an intricate process that involves several factors. The children with a supra-modal such as peripheral hearing, IQ, attention, language disorders and memory deficit may perform poorly on tests of auditory processing, not because they have auditory-specific perceptual problems, but because the test in question is sensitive to other processing demands-such as attention, memory, cognition and motor skills-which are necessary to perform any behavioral task.

APD screening tests for children less than 6 years old need to be developed, this kind of APD screening test especially for this age is limited at this time by the paucity of research regarding effective diagnosis in this age group (Bellis, 2003).

For Egypt, the noise issue, as environmental pollution, ranks second among environmental pollution issues according to the complaint survey (received by Egyptian Environmental Affairs Agency/EEAA) for 2006, It is considered a serious issue because of its harmful impacts on citizens and public health, In the last years, it has been noticed that noise levels in Egyptian streets are disturbingly increasing. These levels have reached unacceptable limits locally and internationally. Measurements indicate that noise levels in major squares and streets may reach approx. 75–85 dB SPL (Ali & Tamura, 2002). On the other hand, especially for the young children, the phonemes identification ability now known to be an important step to a child's early reading acquisition (NICHD, 2000), thus, it is clear why the current study has already selected those two APD aspects: listening in binaural noise and phonemes identification ability disorders.

The purpose of this study was to diagnose two APD aspects: listening in binaural noise and phonemes identification ability disorders for Egyptian children with learning disabilities aged from 5 to 7 years old.

Because there are no regular schools for learning disabilities in Egypt like in Europe and USA, and the children with learning disabilities are distributed among their normal beers, the current study had to screen children in a regular nursery school looking for the children with learning disabilities.

The sequence of the current study experiments as shown in figure 20 was designed to calculate the norms of the developed tests and to find out children with listening in a background of binaural noise or phonemes identification ability disorders.

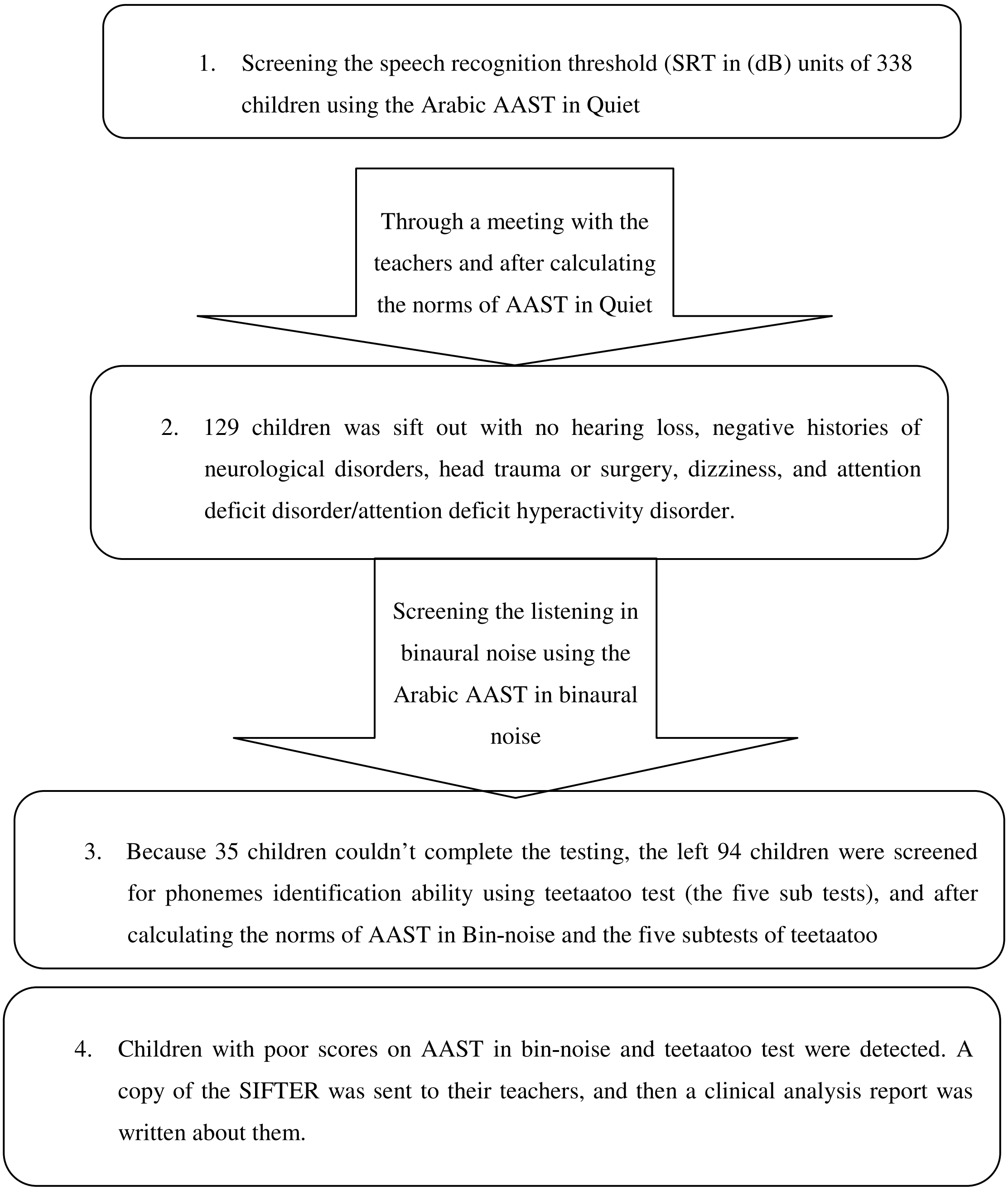


Figure 20. The Sequence of the current study experiments.

4.1. Participants

338 children aged from 5 to 7 years old (138 males, 200 females; mean age = 6.08 years with standard deviation = 0.8) from a regular nursery school which called Baroot Summer Club in Beni-Suef town in Egypt were selected to participate in the study.

4.2. Age

A One-Way ANOVAs (SPSS-Version 12) was utilized to examine if there is significant differences in means of each conducting test as a function of age varying from 5 to 6 to 7 years old.

For AAST in quiet, the total number of the screened children (N= 338) were divided into three groups (1st group (N=60) with mean age = 4,97 years old and S = 0.23; 2nd group (N= 156) with mean age = 5.95 years old and S = 0.24; 3rd group (N=122) with mean age = 6.99 and S = 0.22). As seen in table 20, there was no significant difference between the three means of SRT (1st group with SRT mean = 26,44 dB SPL with S = 5,33; 2nd group with SRT mean = 26,33 dB SPL with S= 5,70; 3rd group with SRT mean = 27,37 dB SPL with S= 6,49) in the three groups because of the age factor, (i.e., the norms of AAST in quiet could be the same for the entire group which aged from 5 to 7 years old).

For AAST in binaural noise, the total number of the screened children (N=129) were divided into three groups ((1st group (N=35) with mean age = 5,00 years old and S = 0.20; 2nd group (N=54) with mean age = 6,06 years old and S = 0.26; 3rd group (N=40) with mean age = 7,03 and S = 0.27). As seen in table 20, there was significant difference between the three means of SRT in binaural noise (1st group mean = -10,8 dB SNR with S = 1,90; 2nd group with mean = -11,53 dB SNR with S= 1,81; 3rd group with mean = -11,95 dB SNR with S= 1,80) in the three groups because of the age factor, (i.e., the norms of AAST in should be different for each definite age group).

For the five subtests in teetaatoo, the total number of the screened children (N= 94) were divided into three groups (1st group (N=22) with mean age = 4,92 years old and S = 0.24; 2nd group (N= 40) with mean age = 6,00 years old and S = 0.27; 3rd group (N=32) with mean age = 7,00 and S = 0.22). As seen in table 20, there was no significant difference between the three means on Cons-A (1st group with score mean = 93,56 % (correct answers) with S = 8,11; 2nd group with score mean = 94.02% with S= 7,63; 3rd group with mean = 94,01 with S= 11,64) in the three groups because of the age factor, (i.e., the norms of Cons-A could be the same for the entire group which aged from 5 to 7 years old).

As seen in table 20, There was no significant difference between the three means on Cons-B1 (1st group with score mean = 76,09 % (correct answers) with S = 14,50; 2nd group with score mean = 80,00% with S= 14,71; 3rd group with mean = 72,46 with S= 16,75) in the three groups because of the age factor, (i.e., the norms of Cons-B1 could be the same for the entire group which aged from 5 to 7 years old).

Also, as seen in table 20, there was no significant difference between the three means on Cons-B2 (1st group with score mean = 86,59 % (correct answers) with S = 9,96; 2nd group with score mean = 89,17% with S= 12,11; 3rd group with mean = 88,54 with S= 13,84) in the three groups because of the age factor, (i.e., the norms of Cons-B2 could be the same for the entire group which aged from 5 to 7 years old).

Further, as seen in table 20, there was no significant difference between the three means on Cons-B3 (1st group with score mean = 75,36 % (correct answers) with S = 14,09; 2nd group with score mean = 75,42% with S= 13,86; 3rd group with mean = 78,12 with S= 13,68) in the three groups because of the age factor, (i.e., the norms of Cons-B3 could be the same for the entire group which aged from 5 to 7 years old).

Finally, as seen in table 20, there was no significant difference between the three means on Vow-A (1st group with score mean = 86,18 % (correct answers) with S = 24,87; 2nd group with score mean = 94,50% with S= 7,14; 3rd group with mean = 91,67% with S= 21,60) in the three groups because of the age factor, (i.e., the norms of Vow-A could be the same for the entire group which aged from 5 to 7 years old).

Table 20.
Summary Table of One-Way ANOVAs Investigating Differences in Means for Each Conducting Test as a Function of Age Variable.

	Source	*Df*	*F*	*P*
AAST in quiet	Between groups	2	1,131	0,324
	With in groups	335		
	Total	337		
AAST in bin-noise	Between groups	2	3,741	0,026*
	With in groups	126		
	Total	128		
Cons-A	Between groups	2	0,02	0,98
	With in groups	90		
	Total	92		
Cons-B1	Between groups	2	1,838	0,166
	With in groups	83		
	Total	85		
Cons-B2	Between groups	2	0,328	0,721
	With in groups	92		
	Total	94		
Cons-B3	Between groups	2	0,411	0,664
	With in groups	92		
	Total	94		
Vow-A	Between groups	2	1,851	0,163
	With in groups	95		
	Total	97		

Note: * Significant at $P < 0.05$

4.3. The Study questions:

The main question of the study is: How the two selected APD (listening in background of binaural noise and the phonemes identification ability disorders could be screened in the Egyptian children aged from 5 to 7 years old?

And to answer this question, there is a need to answer the following sub-questions:

1. What are the norms of AAST in Quiet (peripheral hearing threshold) for the Egyptian children aged from 5 to 7 years old?

2. What are the norms of AAST in binaural noise for the Egyptian children aged from 5 to 7 years old?

3. What are the norms of the ''teetaatoo''test for Egyptian children aged from 5 to 7 years old? And this question is divided into five sub questions according to the phonemes sub categories:

   3.1. What are the norms of the Cons-A sub test (easy set for all the consonants)?

   3.2. What are the norms of the Cons-B1 sub test (for: plosives identification)?

   3.3. What are the norms of the Cons-B2 (for: nasals, trill, approximant and lateral identification)?

   3.4. What are the norms of the Cons-B3 (for: fricatives identification)?

   3.5. What are the Norms of the Vow-A (easy set for vowels identification)?

4. Do the scores of the abnormal cases on the Arabic AAST in binaural-noise and the five subtests in teetaatoo test matches their SIFTER data analysis?

4.3.1. Normative data of AAST in quiet:

To answer the first question which addressed what the norms of AAST in Quiet (peripheral hearing threshold) for the Egyptian children aged from 5 to 7 years old are. The AAST was run over 338 children for screening their speech recognition threshold (SRT) in dB SPL units,

The collected data from screening the speech recognition threshold in dB SPL units of 338 children was with a mean score (M= 26,7 dB SPL), standard deviation (S= 5,94), median which was quiet close to the mean (median= 26,5), and according to the equation of the Pearson Coefficient of Skewness [Sk= 3(mean-median)/S], (Sk= 0,1). A normal quantile-quantile (Q-Q) plot (figure 21) was achieved to examine the normality of the scores distribution which shown a straight line expressing the normality of the scores distribution. Also, the calculated standardized skewness (skew= 0,1) shown that the data comes from a normal distribution, because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003).

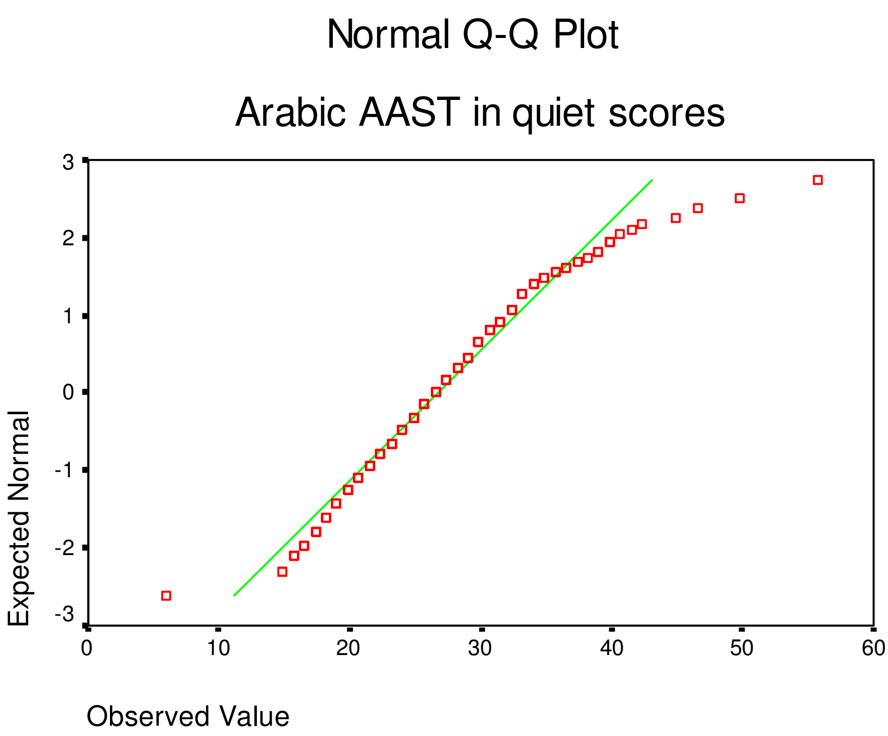


Figure 21

Standard Scores (Norms):

The standard scores can be visually represented by the bell curve (figure 22), (Histogram), Therefore, it could be visually demonstrate where any particular children scores, when compared with other children who are the same age range (5 to 7 years old).

Histogram of the Arabic AAST in Quiet

children aged from 5 to 7 years old

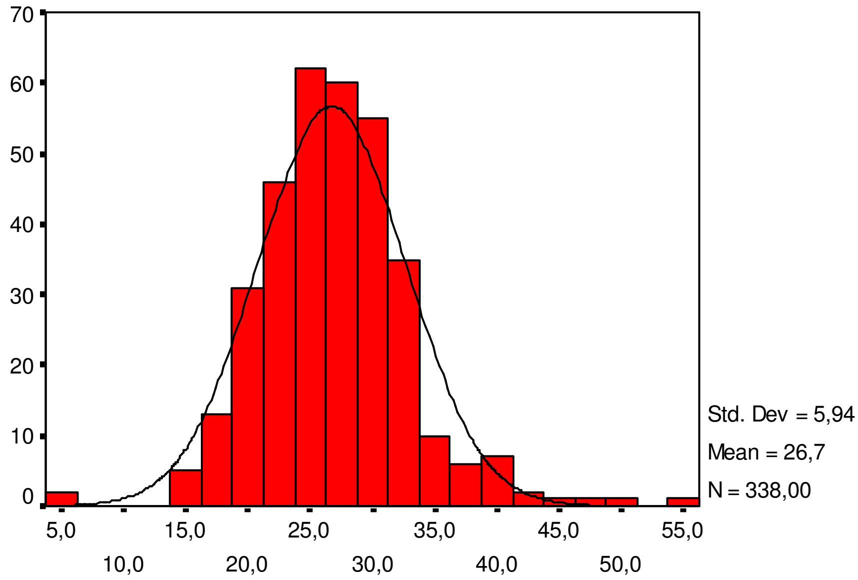


Figure 22

One standard deviation below the mean is 20,76 (≈21 dB SPL) and one standard deviation above the mean is 32,64,(≈33dB SPL) any score that falls between 21 and 33 dB SPL hearing loss is considered to be within the average range. (This would be approximately 68% of the population.) One standard deviation below to two standard deviations below would be 15-21 dB SPL (this is 14% of the population) and one standard deviation above to two standard deviations above would be 33-39dB SPL (this would be approximately 14% of the population.) Two to three standard deviations below would constitute 2% of the population and two to three standard deviations above would constitute another 2% of the population.

Each test uses different descriptors for categorizing ranges of standard scores and may break up the ranges slightly differently. Children within the average range (21-

33 dB SPL) could be considered with normal hearing loss at the age range level (5 to7 years old). Children within (15-21 dB SPL) peripheral hearing loss likely perform above the age range level. Children within (33-39dB SPL) likely are poor or moderately high peripheral hearing loss. Children within (39- 45 dB SPL) and above are considered extremely high peripheral hearing loss, or at severe range, (Gustafson et al., 2006). After applying the previous norms, 16 children were detected with moderately high peripheral hearing loss, and 13 children were detected with extremely high peripheral hearing loss.

4.3.2. Normative data of AAST in binaural noise

As mentioned, there was significant difference especially between the three means of SRT in binaural noise (1st group 5 years, (N=35), mean = -10,8 dB SNR with S = 1,90; 2nd 6 years group, (N=54) with mean = -11,53 dB SNR with S= 1,81; 3rd group 7 years, (N=40) with mean = -11,95 dB SNR with S= 1,80) in the three groups because of the age variable, (i.e., the norms of AAST in should be different for each age group : 5, 6, & 7 years).

First: Norms of AAST in binaural noise within children group aged 5 years.

The collected data from screening the SRT in binaural noise (dB SNR) of children group aged in average five years (N=35) was with a mean score (M= -10,8 dB SNR), standard deviation (S= 1,90), median which was quiet close to the mean (median= -10,5), and according to the equation of the Pearson Coefficient of Skewness [Sk= 3(mean-median)/S], (Sk= 0,47). A normal quantile-quantile (Q-Q) plot (figure 23) showed the normality of the scores distribution because of the straight line which express the normality of the scores distribution. Also, the calculated standardized skewness (skew= 0,47) shown that the data comes from a normal distribution, because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003).

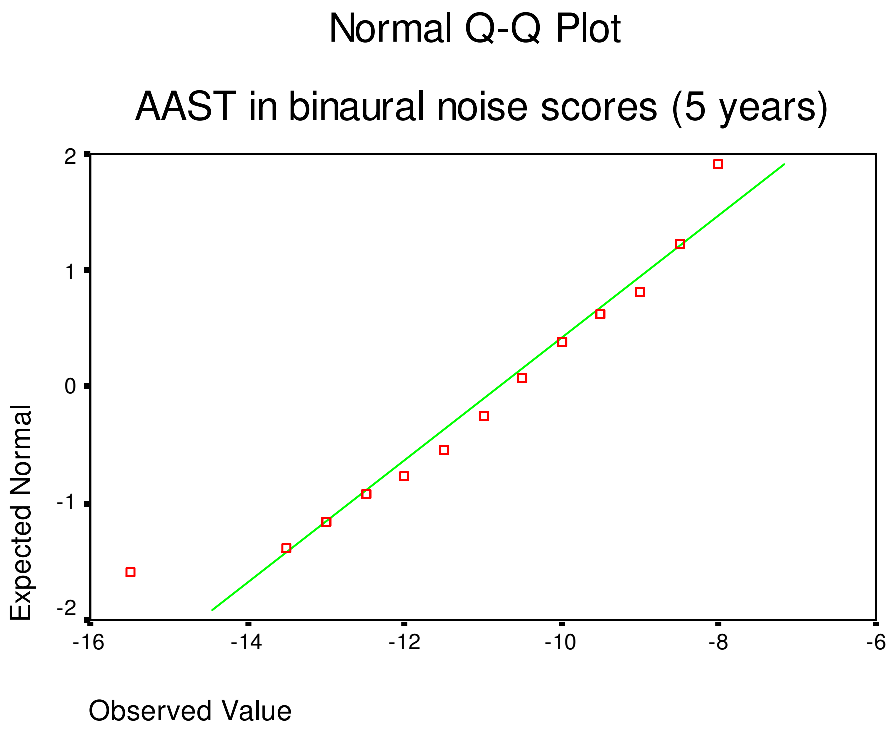


Figure 23

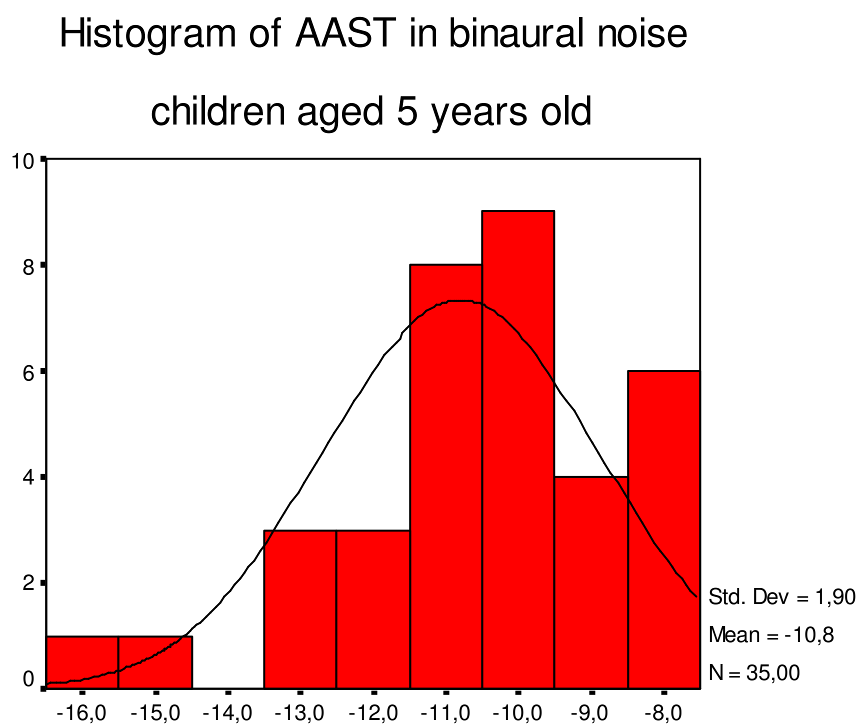


Figure 24

According the histogram (Figure 24) of the scores on AAST in binaural noise of children group aged 5 years old, one standard deviation below the mean is -12,7 (≈-13 dB SNR) and one standard deviation above the mean is -8,9(≈-9 dB SNR) any score that falls between -9 and -13 is considered with a normal auditory processing in a background of binaural noise at the age of 5 years old. Children within (-13 to -15 dB SNR) likely perform above the age range level. Children within (-7 to -9 dB SNR) likely are low, poor, borderline, or moderately low. Children within (-7 to -5 dB SNR) are considered the extremely low, very low or severe range. After applying the pervious norms, 6 children were detected with poor scores. And no children were detected with extremely low.

Second: Norms of AAST in binaural noise within children group aged 6 years.

The collected data from screening the SRT in binaural noise (dB SNR) of children group aged in average six years (N=54) was with a mean score (M= -11,53 dB SNR), standard deviation (S= 1,81), median which was quiet close to the mean (median= -11,5), and according to the equation of the Pearson Coefficient of Skewness [Sk= 3(mean-median)/S], (Sk= -0,05). A normal quantile-quantile (Q-Q) plot (figure 25) showed the normality of the scores distribution because of the straight line which express the normality of the scores distribution. Also, the calculated standardized skewness (Sk= -0,05) shown that the data comes from a normal distribution, because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003).

According the histogram (Figure 26) of the scores on AAST in binaural noise of children group aged 6 years old, one standard deviation below the mean is -13,31 (≈ -13 dB SNR) and one standard deviation above the mean is -9,69(≈ -10 dB SNR) any score that falls between -10 and -13 is considered with a normal auditory processing in a background of binaural noise at the age of 6 years old. Children within (-13 to -15 dB SNR) likely perform above the age range level. Children within (-8 to -10 dB SNR) likely are low, poor, borderline, or moderately low. Children within (-6 to -8 dB SNR) are considered the extremely low, very low or severe range. After applying the previous norms, 5 children were detected with poor scores, while 3 children were detected with extremely low.

Normal Q-Q Plot

AAST in binaural noise scores (6 years)

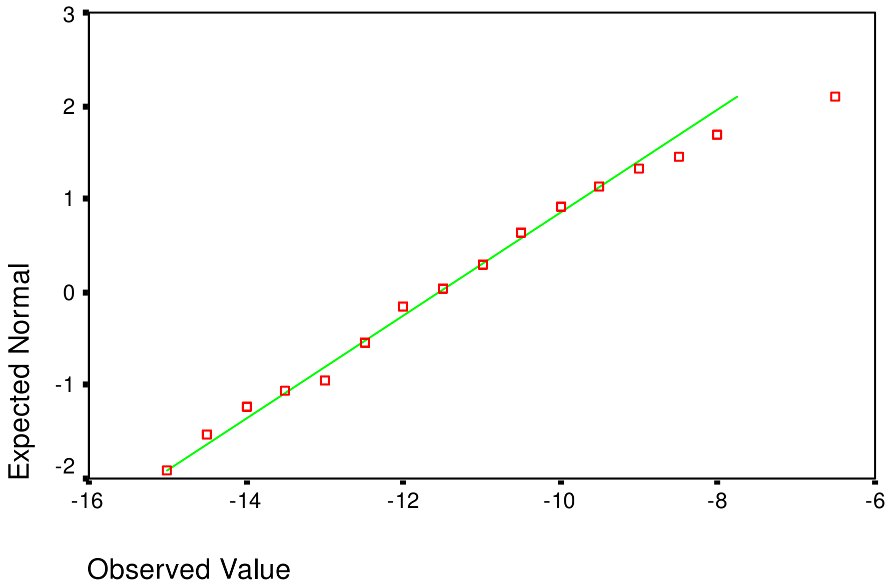


Figure 25

Histogram of AAST in binaural noise

children aged 6 years old

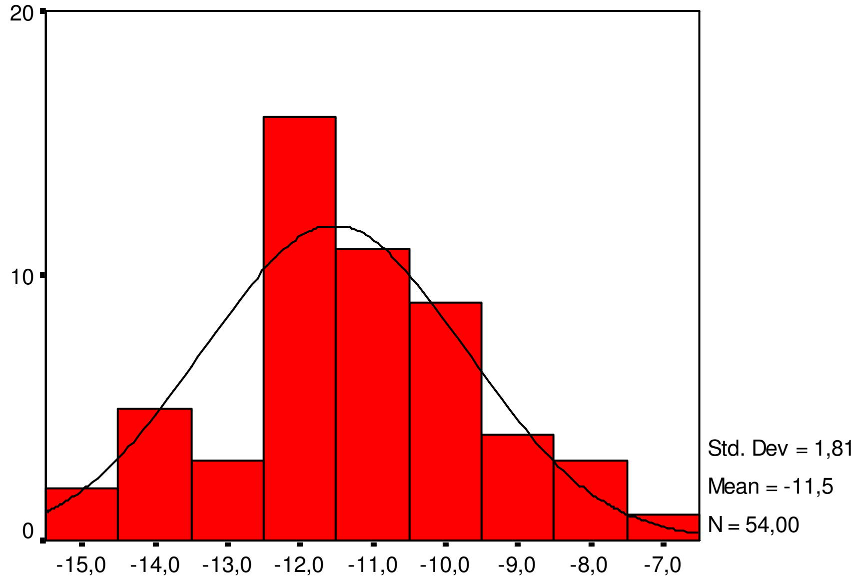


Figure 26

Third: Norms of AAST in binaural noise within children group aged 7 years.

The collected data from screening the SRT in binaural noise (dB SNR) of children group aged in average seven years (N=40) was with a mean score (M= -12 dB SNR), standard deviation (S= 1,8), median which was quiet close to the mean (median= -12), and according to the equation of the Pearson Coefficient of Skewness [Sk= 3(mean-median)/S], (Sk= 0). A normal quantile-quantile (Q-Q) plot (figure 27) showed the normality of the scores distribution because of the straight line which express the normality of the scores distribution. Also, the calculated standardized skewness (Sk= 0) shown that the data have an optimum normal distribution.

According to the histogram (figure 28) of the scores on AAST in binaural noise of children group aged 7 years old, one standard deviation below the mean is -13,8 (≈ -14 dB SNR) and one standard deviation above the mean is -10,2(≈ -10 dB SNR) any score that falls between -10 and -14 is considered with a normal auditory processing in a background of binaural noise at the age of 7 years old. Children within (-14 to -16 dB SNR) likely perform above the age range level. Children within (-8 to -10 dB SNR) likely are low, poor, borderline, or moderately low. Children within (-6 to -8 dB SNR) are considered the extremely low, very low or severe range. After applying the previous norms 4 children were detected with poor scores while one child was detected with extremely low.

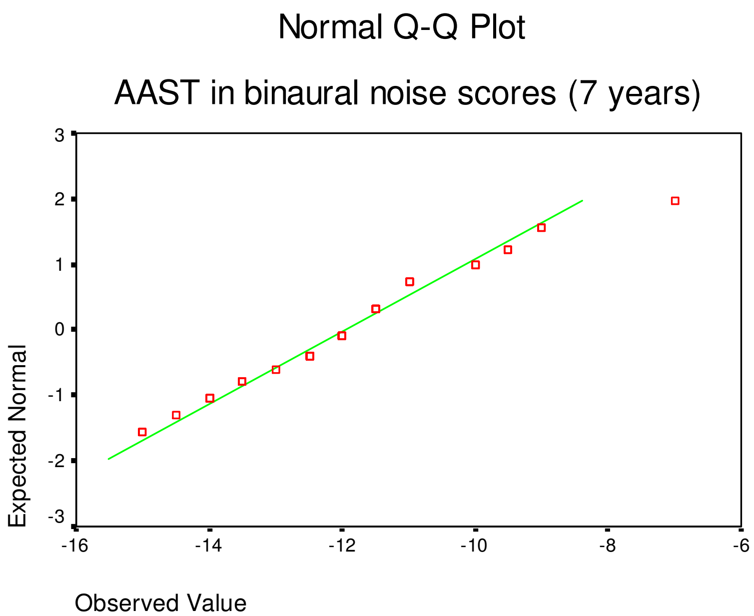


Figure 27

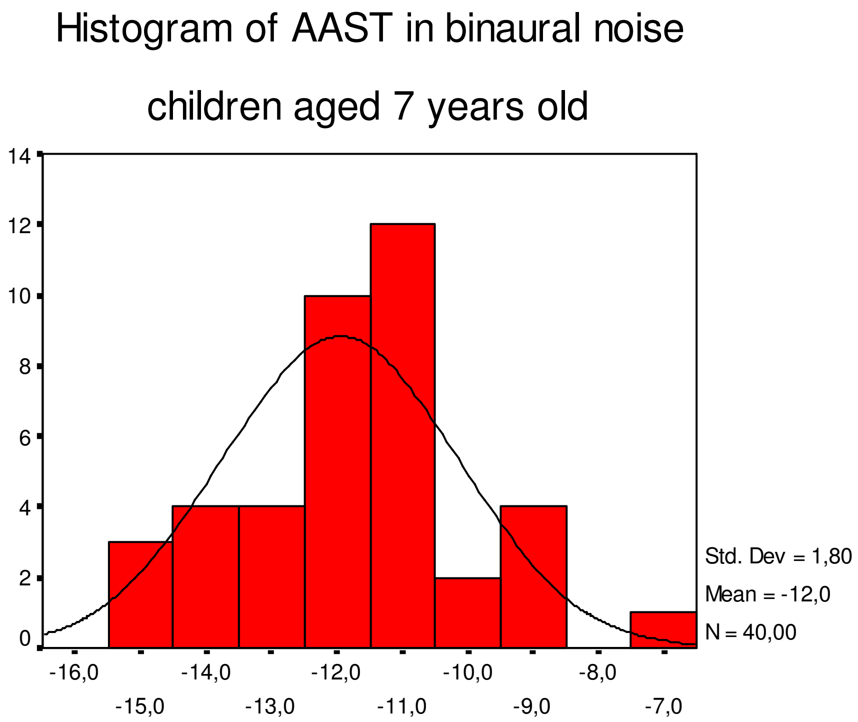


Figure 28

4.3.3. Normative data of Cons-A

Then the left 94 children, because 35 children couldn't complete the testing, were screened for the phonemes identification ability using teetaatoo test(the five sub tests), in order to answer the third question which is consisted of five sub question, and for answering the first sub question which addressed what the norms of the Cons-A sub test (easy set for all the consonants) are. A histogram (figure 29) was plotted using the collected data from screening the left 94 children with the first sub test Cons-A.

From the shown histogram curve in figure 29, most of the children has got the maximum grade (100% correct answers), which is quite normal, because most of the screened children are normal children without any disabilities. Moreover, the Cons-A is an easy test which could be used as an indicator in case of the sever consonants identification disability. Also the shape of the histogram doesn't like the normal one because this Cons-A with a maximum degree (100%), in other words no one can get more than maximum grade (100%).

According to the calculated mean of the children correct answers percentage on Cons-A sub test (M= 93,97 %), median = 100% with standard deviation (S=9,18%). Also, the calculated Pearson Coefficient skewness (Sk= -1,97) shown that the data have a normal distribution because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003). The normal performance level on Cons-A starts approximately from 84,79% (≈85%), while the score 76% to 85% is considered poor, and under the score 76% the child with a very poor level in consonants identification ability. And according to the pervious norms of Cons-A, 17 children with poor scores were detected; 16 children with poor level and only one case with very poor level in consonants identification ability in general.

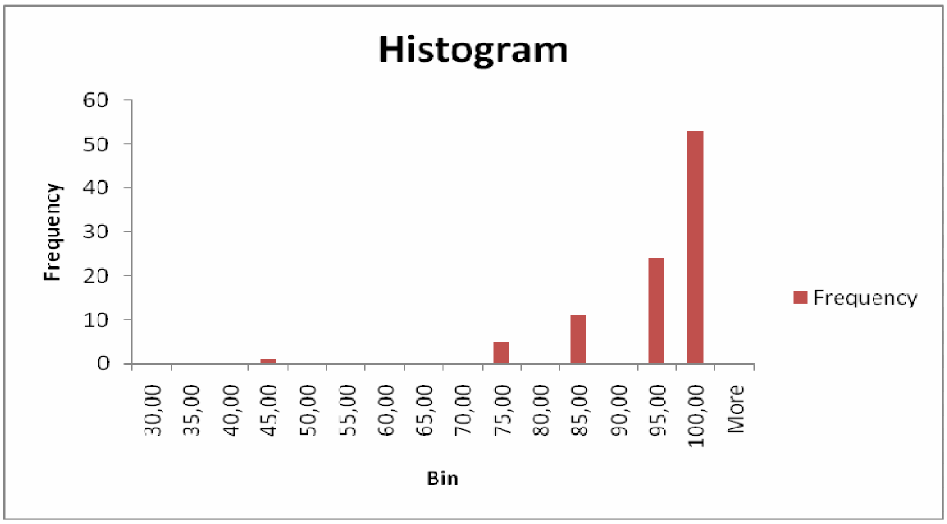


Figure 29. Cons-A threshold of the children from 5 to 7 years old.

4.3.4. Normative data of Cons-B1

Concerning the answer of the second sub question which addressed what the norms of the Cons-B1 sub test (for: plosives identification) are, a histogram (figure 30) was plotted using the collected data from screening the same left 94 children with the second sub test Cons-B1.

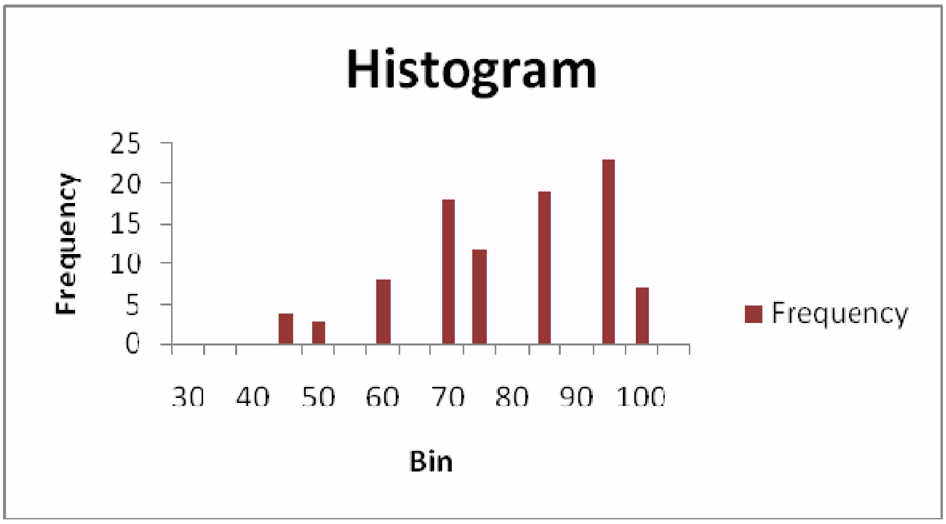


Figure 30. Cons-B1 threshold of the children from 5 to 7 years old.

As shown in figure 30, the shape of Con-B1 histogram has become little bit closer to the normal one, because Cons-B1 is more difficult than Cons-A, in addition, it contains only the plosives phonemes presented in four elements (/b/a, /d□/a, /k/a, and /t□/a).

According to the calculated mean of the children correct answers percentage on Cons-B1 sub test (M= 77,39 %), median = 83,33% with standard deviation (S=15,15%). Also, the calculated Pearson Coefficient skewness (Sk= -1,18) shown that the data have a normal distribution, because the statistic fall between -3 and +3 (Lioyd, 2006; Gibbons & Chakraborti, 2003). Consequently, the normal performance level on Cons-B1 is approximately from 62 to 93 while the score 47% to

62% is considered poor, and under the score 47% is considered with a Very poor level in plosives identification ability. And according to the pervious norms of Cons-B1, 15 children with poor scores were detected; 11 children with poor level and four cases with very poor level in plosives identification ability.

4.3.5. Normative data of Cons-B2

To answer the third sub question which addressed what the norms of the Cons-B2 (for: nasals, trill, approximant and lateral identification) are, a histogram (figure 31) was plotted using the collected data from screening the same 94 children with the third sub test Cons-B2.

As shown in figure 31, the shape of Con-B2 histogram has become little bit a way from the normal one, as well as the histogram of Cons-A, because Cons-B2 contains different consonants subcategories phonemes for the child to choose among them (nasals, trill, approximant and lateral) which are presented in six elements (/j/a, /w/a, /m/a, /n/a, /l ²/a, and /r/a). So Con-B2 is easier than Cons B1.

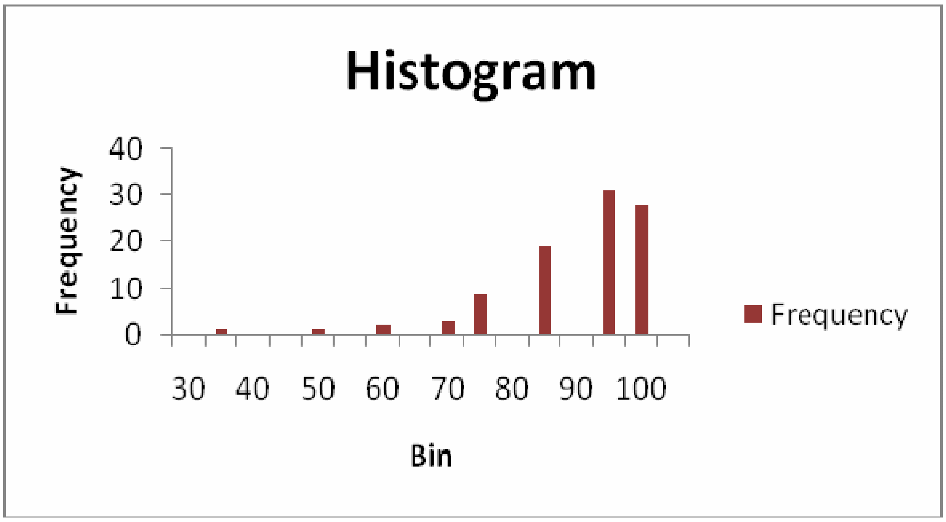


Figure 31. Cons-B2 threshold of the children from 5 to 7 years old.

According to the calculated mean of the children correct answers on Cons-B1 sub test (M= 88,30%), median= 91,67% with standard deviation (S=12,24). Also, the calculated Pearson Coefficient skewness (Sk= -0,83) shown that the data have a normal distribution, because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003). Consequently, the normal performance level on Cons-B2 starts approximately from 76% and up, while the score 64% to 76% is considered poor, and under the score 64% is considered with a very poor level in (nasals, trill, approximant and lateral) identification ability. And according to the pervious norms of Cons-B2, 16 children with poor scores were detected; 12 children with poor level and four cases with very poor level in (nasals, trill, approximant and lateral) identification ability.

4.3.6. Normative data of Cons-B3

To answer the fourth sub question which addressed what the norms of the Cons-B3 (for: fricatives identification) are, a histogram (figure 32) was plotted using the collected data from screening the same 94 children with the fourth sub test Cons-B3.

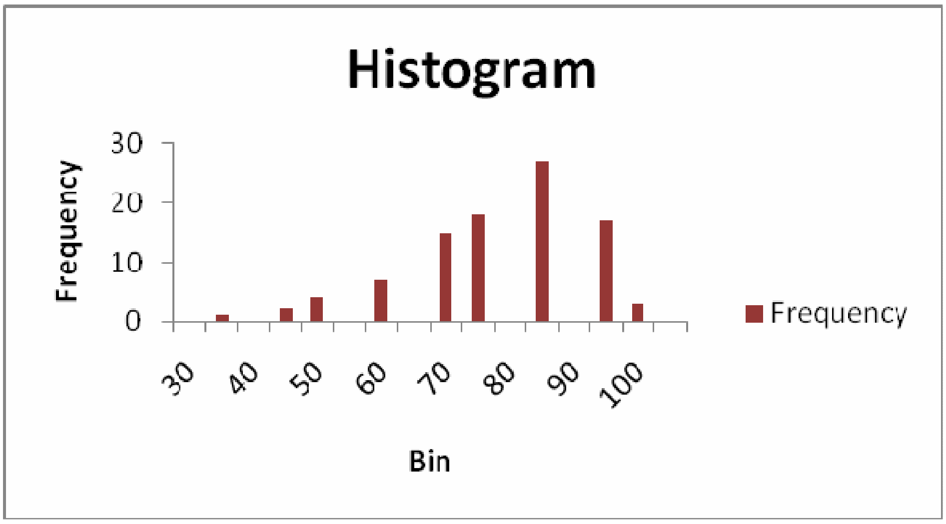


Figure 32. Cons-B3 threshold of the children from 5 to 7 years old.

As shown in figure 32, the shape of Con-B3 histogram is very close to the normal one, because Cons-B3 is the most difficult one because it contains only the fricatives phonemes presented in six elements (/f/a, /□/a, /x/a, /θ/a, /s/a, and /ħ/a).

According to the calculated mean of the children correct answers on Cons-B1 sub test (M= 76,42 %), median = 79,17% with standard deviation (S=13,80%). Also, the calculated Pearson Coefficient skewness (Sk= -0,6) shown that the data have a normal distribution, because the statistic fall between -3 and +3, (Lioyd, 2006; Gibbons & Chakraborti, 2003). Consequently, the normal performance level on Cons-B3 is approximately from 63% to 90% while the score 49% to 63% is considered poor, and under the score 49% is considered with a very poor level in fricatives identification ability. And according to the pervious norms of Cons-B3, 14 children with poor scores were detected; 11 children with poor level and three cases with very poor level in fricatives identification ability.

4.3.7. Normative data of Vow-A

To answer the fifth and the last sub question which addressed what the norms of the Vow-A (easy set for vowels identification) are, a histogram (figure 33) was plotted using the collected data from screening the same 94 children with the fifth sub test Vow-A.

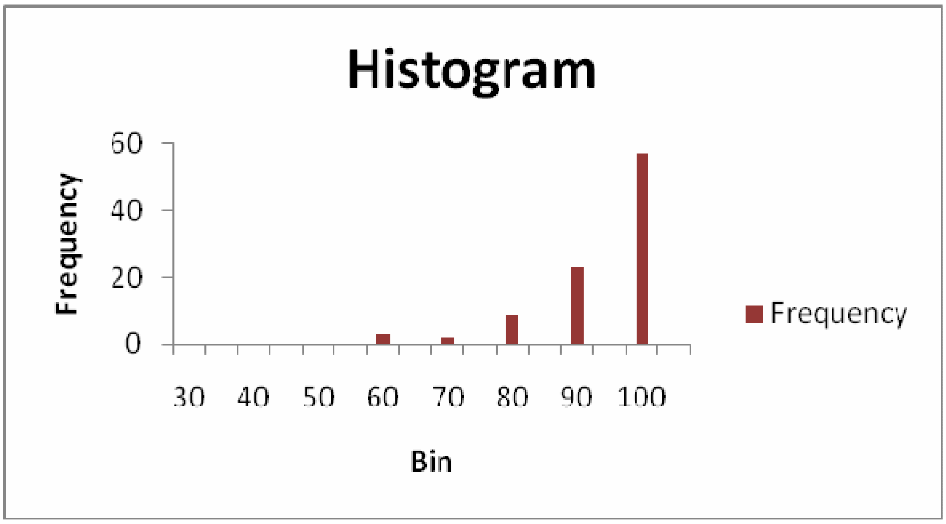


Figure 33. Vow-A threshold of the children from 5 to 7 years old.

As shown in figure 33, the shape of Vow-A histogram looks like the histogram of the Cons-A, because both of them are easy sets. Vow-A is the only V-set for identifying the different Arabic Vowels which contains five elements; the long forms of the three Arabic vowels (t/a:/, t/i:/, and t/u:/) and two diphthongs (t/aj/ and t/aw/).

According to the calculated mean of the children correct answers on Cons-B1 sub test (M= 93,72), median = 100% with standard deviation (S=9,73), Also, the calculated Pearson Coefficient skewness (Sk= -1,94) shown that the data have a normal distribution, because the statistic fall between -3 and +3 (Lioyd, 2006; Gibbons & Chakraborti, 2003). Consequently, the normal performance level on Vow-A starts from 83,99 while the score 74,26% to 83,99% is considered poor, and under the score 74,26% is considered with a very poor level in vowels identification ability. And according to the pervious norms of Vow-A, 14 children with poor scores were detected; 9 children with poor level and five cases with very poor level in vowels identification ability.

4.4. Clinical analysis of the children with poor scores:

As seen in table 21, all the cases with poor scores on the Arabic AAST in bin-noise and teetaatoo test (the five sub tests) are divided into: cases with poor and cases with severe poor scores, and for more investigating of these cases with the poor scores, a copy of a SIFTER was sent to the teachers of those cases to indicate children with listening speech in bin noise and phonemes identification abilities disorders who may be experiencing educational difficulties as a result of their APD.

The children responses were plotted on a chart which indicates *pass* (49-75) *marginal (38-44)* or *fail (<33)* for each of the five content areas: academics, attention, communication, class participation, and school behavior. The SIFTER results have shown that 13 from the 23 who scored poorly on AAST in bin noise failed, 8 were at the marginal and only two of them passed. And for those who scored poorly on Cons-A, 10 from 17 failed, 4 were at the marginal and three of them passed, for Cons-B1, 9 from 15 failed, 4 were at the marginal and only two of them passed, for Cons-B2, 7 from 16 failed, 5 were at the marginal and four of them passed, for Cons-B3, 8 from 14 failed, 3 were at the marginal and 3 were passed, for the Vow-A, 5 from 14 failed, 5 were at the marginal, and four of them passed.

Table 21.

Summary Table of All the Cases with Poor Scores

	AAST in bin-noise (in dB SNR units)	**Cons-A**	**Cons-B1**	**Cons-B2**	**Cons-B3**	**Vow- A**
	N=129			N=94		
Very poor norm(approx.)	> -8 >-7 (5 years)	<76%	<47%	<64%	<49%	<74%
No. of cases	4	1	4	4	3	5
Poor norm(approx.)	-8 to -10 -7 to -9(5years)	76%-85%	47%-62%	64%-76%	49%-63%	74%-84%
No of cases	21	16	11	12	11	9

Only the failed cases on the SIFTER, with poor scores on AAST in bin-noise, and completed teetaatoo test were clinically analyzed using all the available data from the conducted tests in the current study, presenting a kind of a small cognitive profile for each case in order to diagnose every case. There were few cases with poor scores in more than one test in the mean time, so what will be mentioned in AAST in noise will not be repeated again in the teetaatoo subtests, and this is the reason of the low no of cases with poor cases than which was written above.

Table 22. Image Profile Analysis of the Children with Poor Scores and Failed on SIFTER

Test	AAST in quiet		AAST in bin-noise	Cons-A	Cons-B1	Cons-B2	Cons-B3	Vow-A	SIFTER
Objective	Speech recognition threshold in dB units		Listening in bin-noise in dB SNR	Consonants identification ability (easy set)	Plosives identification	nasals, trill, approximant and lateral identification	Fricatives identification	Vowels identification (easy set)	Educational status
Normal norm	21 - 33		-9 to-13 -10 to-13 -10 to-14	>85%	>62%	>76%	>63%	>84%	49-75
	Left ear	Right ear							
1(6years)	23	23	-6,5	75	42	58	42	90	22
2(6years)	25	27	-9,5	92	42	100	75	100	32
3(6years)	30	27	-9,5	83	42	83	83	100	31
4(7years)	23	22	-9,5	92	58	75	75	100	30
5(6years)	30	28	-9,0	100	67	100	75	100	25
6(6years)	27	27	-9,5	92	83	75	67	80	33
7(6years)	25	25	-8,00	100	75	92	58	100	29
8(7years)	27	27	-9,0	100	67	92	83	80	27
9(5years)	26	26	-8,5	100	42	83	67	70	33
10(5years)	15	17	-8,5	100	92	100	83	100	31
11(7years)	27	30	-8,00	92	100	83	75	100	30
12(5years)	27	27	-8,00	100	92	100	92	90	31
13(7years)	28	30	-9,00	92	83	100	83	100	33
14(6years)	23	23	-12	83	92	58	33	100	33
15(5years)	25	25	-11	75	67	50	67	90	29
16(6years)	31	26	-10,5	83	50	83	92	100	31
17(7years)	29	29	-11,5	83	58	83	67	100	32
18(6years)	32	32	-15,5	83	58	83	50	100	33
19(6years)	28	31	-10,00	83	67	75	50	70	33
20(5years)	24	22	-11	75	58	83	58	100	32
21(6years)	27	24	-11	83	67	83	92	100	33
22(7years)	30	29	-11,5	92	67	33	58	60	29
23(6years)	17	19	-11	92	92	92	58	100	33

As shown in table 22, 23 cases represent 17,8% from the whole sample (N=129) with a normal speech recognition threshold have scored poorly on the speech listening in bin-noise (AAST in bin-noise) or on at least one subtest from teetaatoo subtests and have failed on the SIFTER in the mean time, these children with a normal peripheral Hearing who couldn't recognize the sound of the spoken words in a background of bin-noise or couldn't identify even one phonemes category and educationally at risk according to their results on SIFTER are at risk for APD, especially, those ten children who failed on three APD tests in addition to the SIFTER.

Whilst the Arabic AAST in quiet, AAST in bin-noise and teetaatoo may provide valuable information in assessing two important auditory functions, they are not, in themselves, a valid indicator of APD. Rather, all aspects of the child's performance must be analyzed in determining their suitability for diagnostic testing, or in categorizing a child with APD.

4.5. Discussion:

The aims of this study were to develop and to provide the normative data of Arabic screening tool for screening the children with auditory processing disorders: an Arabic version of Adaptive auditory speech test (AAST) in quiet for screening the peripheral hearing in dB SPL units, as a first step, an Arabic AAST in binaural noise for screening the temporal interaction deficit: listening speech in binaural noise, then teetaatoo test with a five subtests for screening the Modern Standard Arabic language phonemes identification ability.

For the AAST in quiet, 21 to 33 dB SPL is the normal range of the hearing peripheral loss. There are three different norms, especially, for the AAST in binaural noise; -9 to -13 dB SNR is the normal range of children aged 5 years old, -10 to -13 dB SNR is the normal range of children aged 6 years old, and -10 to -14 dB SNR is the normal range of children aged 7 years old. Finally, for the five subtests (teetaatoo) : > 85% (correct answers) is the normal percentage of the Cons-A, >62& (correct answers) is the normal percentage of the Cons-B1, >76% is the normal percentage of the Cons-B2, >63% (correct answers) is the normal percentage of the Cons-B3, and 84% (correct answers) is the normal percentage of the Vow-A.

As mention in table 20, there were no significant differences in the phonemes identification abilities because of the varying in age from 5 to 7 years old, thus, only one norm of normal performance was developed for whole the study sample aged from 5 to 7 years, which may be because the early maturation of this cognitive ability (phonological awareness) in line with Lonigan et al., (2000) & Bertoncini et al., (2009) who found a high level of stability in a longitudinal measure of phonological awareness in which the performance of 5-year-old preschoolers on a series of tasks perfectly predicted the same children's performance on similar tasks in kindergarten and first grade.

While the current study had to provide three different norms for listening speech in binaural noise because of the varying in age from 5 to 7 years old, which may be because listening speech in noise or degraded speech strain the auditory pathways of the central nervous system more than the recognition of unaltered speech or speech in quiet, hence, it is necessary to obtain normative data for each age especially for this kind of tasks (Ollendick & Schroeder, 2003, 87).

According, the calculated normative data and the mentioned above, 129 children were screened for any APD risk, using the developed minimal APD battery, and after excluding the successful cases on the SIFTER, 23 children were detected as cases with poor scores, with 17,8% ratio.

The 17,8 % ratio of those children at risk for APD equals more than the double of the international ratio of the children with APD, whereas 7% of children are estimated Roughly to have (C)APD (Bamio et al., 2001), which might be because unsuitable living conditions in Egypt compared to the European countries or in USA, especially, the noise levels, whereas the noise issue in Egypt, as environmental pollution, ranks second among environmental pollution issues according to the complaint survey (received by Egyptian Environmental Affairs Agency/EEAA) for 2006, It is considered a serious issue because of its harmful impacts on citizens and public health, In the last years, it has been noticed that noise levels in Egyptian streets are disturbingly increasing. These levels have reached unacceptable limits locally and internationally. Measurements indicate that noise levels in major squares and streets may reach approx. 75–85 dB SPL (Ali & Tamura, 2002).

Also, many previous studies on the etiology of auditory processing disorders have proved that low level carbon monoxide, lead exposure in children may affect sites in the CANS producing auditory processing disorders (Edmon, 1998; Musiek & Lee, 1999; Dietrich et al., 1992). Hence, The air pollution in Egypt might be an important second reason for the high ratio of children at APD risk, Actually, it is a serious problem in thickly populated and industrialized areas, especially in greater Cairo area, whereas the conducting of the current study tests was in Beni-suef; the closest town to the greater Cairo. The Carbon monoxide, for the year 2000 presented the most critical air quality problem in Egypt, primarily due to high background values resulting from dust blown from the desert. The highest recorded PM10 values were found in industrial and heavy traffic areas, also a high concentration of Lead which reaches 0.5-10 annual mean 1.5 quarterly mean (Ramadan, 2009; Elraey et al., 2006).

Unfortunately, there were not available data by other researches about the estimated ratio of the APD children until this moment and according to the researcher abilities to compare it with the current study out comes.

4.6. Future Research

The following researches are suggested for the future:

- Completing the Arabic developed battery in this study for screening auditory processing disorders with the children by adding: temporal resolution deficits tests: the gap detection, temporal sequencing: auditory stimuli ordering tasks, temporal integration: processing different auditory stimuli in the both ears in the mean time in order to have a complete Arabic battery for screening the APD with the Arabic children, and conducting this new battery over a wide age range in more than one country, producing a clear image about the fact of APD and its impacts all over life fields.
- Developing a treatment or a remediation in a kind of training programs for the children at risk of APD.
- Screening the pupils in the regular schools, using the AAST in quiet to detect the children with minimal hearing loss, who are most likely diagnosed as a learning disabled or a children with APD, and solving their suffering by offering them the suitable hearing aids.
- No doubt that the individuals who suffer from disorders in auditory processing expose to social, emotional and behavioral difficulties, and communication defects may have opposite influence on the growth of their self -esteem and self-respect, therefore, studying the psychological issues accompanying the children with APD would be beneficial.
- Studying the cases with more than one deficit accompanied together, for instance: the APD cases accompanied with ADHD or mental retardation, how are the both disabilities could be diagnosed and treated in the mean time?

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APPENDIX A

STANDARD ARABIC CONSONANT PHONEMES

Standard Arabic consonant phonemes

		Bilabial	Labio-dental	Inter-dental	Dental (incl. alveolar)		Post-alveolar	Palatal	Velar	Uvular	Pharyn-geal	Glottal
					plain	emphatic						
Plosive	voiceless				ت t̪?	ط t̪? ?			ك k	ق q		ء ?
	voiced	ب b			د d̪?	ض d̪? ?	ج dʒ?¹					
Fricative	voiceless		ف f	ث θ	س s	ص s?	ش ʃ?		خ x		ح ħ?	ه h
	voiced			ذ ð	ز z	ظ ð?			غ ?		ع ?	
Nasal		م m			ن n							
Lateral					ل l¹							
Trill					ر r							
Approximant		و w						ي j				

APPENDIX B

ARABIC CONSONANT PHONEMES FREQUENCY

Phoneme	Frequency	Arabic	Phoneme	Frequency	Arabic
/dʒ/	10%	ج	/r/	24%	ر
/k/	9%	ك	/w/	18%	و
/h/	8%	ه	/l/	17%	ل
/z/	8%	ز	/m/	17%	م
/tˤ/	8%	ط	/n/	17%	ن
/x/	8%	خ	/b/	16%	ب
/sˤ/	7%	ص	/f/	14%	ف
/ʔ/	7%	ء	/ʕ/	13%	ع
/t/	6%	ت	/q/	13%	ق
/dˤ/	5%	ض	/d/	13%	د
/ɣ/	5%	غ	/s/	13%	س
/θ/	3%	ث	/ħ/	12%	ح
/ð/	3%	ذ	/j/	12%	ي
/ðˤ/	1%	ظ	/ʃ/	11%	ش

APPENDIX C

THE ARABIC ARTICLE

آراء قضايا و

الأثنين هـ 6 من شوال 1429 6 أكتوبر 2008 العدد-133 السنة 44499

الاستراتيجية المصرية الجديدة ؟!

بقلم : د. عبد المنعم سعيد

عنوان هذا المقال مقتبس من عنوان مقال للدكتور محمد السيد سليم - أستاذ العلوم السياسية بكلية الاقتصاد والعلوم السياسية والمدير الاسبق لمركز الدراسات الآسيوية بجامعة القاهرة - بعنوان الاستراتيجية الصينية الجديدة ونشرته صحيفة العربي الغراء في28 سبتمبر المنصرم, والمقال غني بتفاصيل كثيرة, ولكنه قدم خلاصة النتائج التي توصل إليها الكاتب اثناء مشاركته في المؤتمر الثالث لمنتدي شنغهاي للدراسات الصينية لما يمكن اعتباره الاستراتيجية الصينية في التعامل مع العالم المعاصر, هذه الاستراتيجية يمكنها ان تكون مفيدة لمصر من جوانب كثيرة, بل لعلها تساهم في النقاش المصري العام الذي قد يحدث يوما ما لبناء استراتيجية جديدة لمصر تحصل علي توافق عام بين القوي السياسية المختلفة.

وبالطبع ودون ذكر الكثير من التفاصيل فان هناك فارقا هائلا بين الصين ومصر, ومن الناحية السكانية البحتة فان هناك فارقا بين مليار و300 مليون من المواطنين, ودولة عدد سكانها80 مليونا, كما ان هناك فارقا بين دولة مساحتها تزيد علي مساحة العالم العربي كله أو تساوي مساحة الولايات المتحدة الأمريكية, ودولة مساحتها مليون كيلو متر مربع, وبالتأكيد فان هناك فارقا بين دولة نووية وذات مقعد دائم في مجلس الأمن الدولي, ودولة ليس لديها أي من ذلك, ودولة لا تزل شيوعية من الناحية السياسية علي الأقل, واخري بعدت بها المسافات عن الاشتراكية, ورغم ان الدولتين بدأتا معا طريق الاصلاح الاقتصادي والسياسي معا في نهاية سبعينيات القرن الماضي فان الصين سارت في هذا الطريق بخطوات واسعة محققة واحدا من أعلي معدلات النمو الاقتصادي المستقرة طوال التاريخ بينما تراوحت الأحوال المصرية بين سنوات قليلة من النمو وسنوات أكثر من الانكماش.

وبينما استقرت النخبة السياسية الصينية علي ماسمته السوق الاجتماعي لتمييزها عن السوق الرأسمالي فان النخبة المصرية لاتزال مترددة ومتراوحة ما بين السير في اتجاه اقتصاد السوق أو التراجع عنه كلما ظهرت المشكلات الناجمة عن الحراك الاقتصادي.

ومع ذلك فان هناك بعضا من انواع التشابه بين البلدين, فكلاهما بلد قديم له تراث كبير في التاريخ البشري, وبشكل ما لديه ثقافة تميل إلي الاعتقاد انه مركز العالم, وكلاهما في كل الاحوال يعد بلدا ناميا يعاني من معضلات التنمية ومكافحة الفقر والتعامل مع عالم يجري تكنولوجيا وماديا وحتي ثقافيا بسرعة الضوء.

وبشكل من الاشكال فان كلاهما حاول خلال العقود القليلة الماضية التعامل مع عصره وعالمه, بوسائل متنوعة, ومن الناحية المصرية علي الأقل فان هناك ميلا قويا إلي التعلم من النموذج الصيني نظرا للعلاقات المصرية - الصينية القديمة ولاعتقاد ذائع ان التجربة الصينية هي الاقرب للتجربة المصرية.

ومن هذه الزاوية الأخيرة فان مقال الاستاذ الدكتور محمد السيد سليم يقدم لنا قائمة مفيدة للغاية كدليل لفهم ما يجري في الصين وربما مايجري في مصر ايضا. فقد كان أول ما رصده من عناصر الاستراتيجية الصينية هو التأكيد المستمر علي سلمية الصعود الصيني بمعني ان صعود الصين لاينبغي له, ان يشكل تهديدا للقوي الأخري بل انه يأتي في إطار الانسجام والتكامل معها ومن ثم فان الصين لم تعد تتحدث عن عالم متعدد الاقطاب أو تنتقد الهيمنة الأمريكية أو حتي وجود خلافات جذرية تتعلق بالنزاعات الدولية القائمة. وفي الحقيقة, انه منذ عامين شاركت في مؤتمر دولي عقده مركز الدراسات الدولية والاستراتيجية في واشنطن عن العلاقات الصينية الأمريكية وكانت اغلبية المشاركين فيها من الباحثين والخبراء الصينيين والأمريكيين, وكانت الرسالة الصينية الواضحة بشدة هي ما جاء في الاستنتاج ان الصعود الصيني ليس علي حساب احد, ولاحساب الولايات المتحدة أو غيرها,

وهو سلمي في جميع أوجهه حتي ان الصين قدمت تنازلات جوهرية لحل مشاكل الحدود مع جيرانها. ولفت النظر في الخطاب الصيني تقديره للدور الأمريكي في منطقة الخليج حيث تجري حماية منابع النفط من قوي متطرفة وهو مايحمي مصلحة صينية استراتيجية حيث ان اعتماد بكين علي بترول الخليج اكبر بكثير من اعتماد واشنطن عليه.

مثل هذا التوجه ليس موجودا لدي قطاع هام من النخبة السياسية المصرية حيث تري انه لايمكن ان يكون هناك صعود للدور المصري بدون ان يكون جوهر هذا الصعود هو المواجهة سواء مع إسرائيل أو مع الولايات المتحدة وفي احيان مع الغرب كله. ولايعد ذلك ممثلا للفارق بين البلدين من حيث المشاكل الاستراتيجية حيث ان الصين ليس لديها مشاكل استراتيجية مع جميع جيرانها فقط, بل ان بعضا من ارضيها تم انتزاعها منها مثل هونج كونج ومكاو وعندما عادت فانها عادت بنظامها السياسي والاقتصادي والاجتماعي وحتي الثقافي الخاص بها في قيود علي السيادة الصينية لو كان بعضا منها واقعا في مصر لكان الرفض الفوري نصيبه من النخبة السياسية المصرية.

ولكن هذا الموقف الصيني ليس منبت الصلة بالعنصرين التاليين في الاستراتيجية الصينية, كما توصل لهما الدكتور محمد السيد سليم وهما ان هناك تحديات مشتركة تواجه العالم المعاصر تجب انواع التناقض المختلفة بين القوي الدولية الكبري بما فيها حتي موضوع حيوي للصين مثل قضية تايوان. فالصين الحديثة لاتريد رهن قضايا مثل الإرهاب والاحتباس الحراري والايدز والغذاء والطاقة لمسألة استعادة تايوان إلي الوطن الام حتي ولو كان العالم كله لايعترف إلا بوجود صين واحدة, والأهم من ذلك ان حل المعضلة التايوانية لايكون إلا من خلال التطبيع التدريجي للعلاقات والجسور بين تايوان والصين الشعبية.

مثل هذا المنهج في السياسة الخارجية يكاد يكون غائبا تماما عن رغبة النخبة السياسية والفكرية المصرية التي لاتري في العلاقات والجسور سواء مع إسرائيل أو الولايات المتحدة إلا اشكالا مختلفة من الاستسلام والتراجع والتناقض مع علاقات تاريخية مع دول عربية وإسلامية وبطرق مختلفة فان هذه النخبة المصرية, ووراءها نخبة عربية واسعة, لاتزال تتبني الاستراتيجية الصينية القديمة التي تري ان المقاطعة والعزلة والصراع هي الطريقة الوحيدة لاستعادة حقوق مسلوبة متمثلة في تايوان التي كانت دوما جزءا من التراث التاريخي الصيني. وفيما يبدو ان الصين ادركت مالم تدركه النخبة العربية ان استعادة الحقوق في العالم المعاصر لها قواعد مختلفة عما كان عليه الحال في عقود سابقة, أو أنه آن الأوان لاتباع اساليب ناجحة للحصول علي الحقوق بتوافق دولي بدلا من وسائل مدمنة للفشل تقوم علي تحقيق توافق دولي مضاد للحقوق المشروعة!.

ولكن مثل هذا المنهج الصيني لم يأت من فراغ وانما من عنصر ثالث في الاستراتيجية الصينية الجديدة يقول - كما جاء في مقال الدكتور سليم - ان الصين يجب ان تتبع سياسة خارجية تتفق مع مقدراتها لانها تواجه معضلات داخلية كبري لاتمكنها من الاضطلاع بدور عالمي. ولعل ذلك هو جوهر الموضوع, فالحقيقة المتواضع عليها عالميا هو انه لاتوجد ما يسمي بالسياسة الخارجية للدول وانما توجد سياسات داخلية, وفي البلاد النامية, وحيث تنتشر مستويات متعددة من الفقر والجهل والمرض وانعدام العدالة الاجتماعية, فان الحديث عن دور عالمي أو حتي دور اقليمي زائد عن الحاجة يعد نوعا من عدم المراعاة لمقتضي الحال.

وحينما قامت بعثة صحفية من الأهرام بزيارة الصين عام1998 في وقت كانت فيه الصين تحقق معدلات للنمو قدره7,8% حتي في زمن الازمة الاقتصادية الآسيوية بمقابلة رئيس الوزراء رونجي الذي قال ما كان لافتا للنظرساعتها انه مهما حققت الصين من معدلات مرتفعة فانها سوف تظل وفق كل المعايير بلدا فقيرا حتي منتصف القرن الحادي والعشرين.

قارن ذلك بالفكر الذائع في مصر عن الدور الاقليمي المصري الذي يتحرك في دوائر ومجالات وقارات لو أخذت بجدية لكان الأمر متعلقا بدولة عظمي يتخطي نصيب الفرد فيها من الدخل القومي مالدي إسرائيل أو تركيا علي الاقل, ويكون جميع أهلها متعلمين تعليما راقيا, ولها نصيب وافر من انتاج التكنولوجيا العالمية. ولكن الكلام في مصر ليس له ثمن كبير حيث تختلط الأحلام بالأوهام, وتنفصل الفكرة عن القدرة, اما في الصين فإن الكلام له ثمن كبير, بل إن هناك حرصا علي كلام أقل وفعل أكثر, وعلي طريق ذلك توجد تقديرات وأولويات ربما يدلل عليها بشدة ما أشار له الدكتور سليم بالنظرة إلي العلاقة العربية - الصينية.

فعندما تتوافر مثل هذه الاستراتيجية الجديدة لدي الصين فانها لابد أن تحسب بحسابات دقيقة عمق علاقاتها مع الأطراف الأخري تبعا لعمق المصالح والعوائد والتكاليف, ووفق ذلك كله فان قيمة العالم العربي بالنسبة للسياسة الصينية محدودة, ولذلك فان التجارة والاستثمار والصلات مع العرب محدودة كذلك, بل ان منظمي المؤتمر المشار إليه عالية في شانغهاي لم يقوموا بنشر أعمال المشاركين العرب كما فعلوا مع بقية باحثي العالم. الدرس الذي نتعلمه من هنا هو ان تحسب مصر مصالحها مع كل الأطراف في المنطقة وفي العالم, وتبحث في المدي الذي تريد لهذه المصالح ان تتسع في المدي القصير والمتوسط, وبناء عليه ترسم سياستها, وتستخدم ادواتها, فالمسألة في البداية والنهاية هي المصالح, وقديما قال السلف الصالح اطلبوا العلم ولو في الصين وقد جاءنا المقال المنشور في العربي الغراء بعلم غزير!!.

APPENDIX D

SIFTER

(SCREENING INSTRUMENT FOR TARGETING EDUCATIONAL RISK)

S.I.F.T.E.R.

SCREENING INSTRUMENT FOR TARGETING EDUCATIONAL RISK

by Karen L. Anderson, Ed.S., CCC-A

STUDENT ______________________ TEACHER ______________ GRADE ________

DATE COMPLETED __________ SCHOOL ______________________ DISTRICT __________

The above child is suspect for hearing problems which may or may not be affecting his/her school performance. This rating scale has been designed to sift out students who are educationally at risk possibly as a result of hearing problems. Based on your knowledge from observations of this student, circle the number best representing his/her behavior. After answering the questions, please record any comments about the student in the space provided on the reverse side.

Question						Area	Score
1. What is your estimate of the student's class standing in comparison of that of his/her classmates?	UPPER 5	4	MIDDLE 3	2	LOWER 1	ACADEMICS	☐
2. How does the student's achievement compare to your estimation of her/her potential?	EQUAL 5	4	LOWER 3	2	MUCH LOWER 1		
3. What is the student's reading level, reading ability group or reading readiness group in the classroom (e.g., a student with average reading ability performs in the middle group)?	UPPER 5	4	MIDDLE 3	2	LOWER 1		
4. How distractible is the student in comparison to his/her classmates?	NOT VERY 5	4	AVERAGE 3	2	VERY 1	ATTENTION	☐
5. What is the student's attention span in comparison to that of his/her classmates?	LONGER 5	4	AVERAGE 3	2	SHORTER 1		
6. How often does the student hesitate or become confused when responding to oral directions (e.g., "Turn to page . . .")?	NEVER 5	4	OCCASIONALLY 3	2	FREQUENTLY 1		
7. How does the student's comprehension compare to the average understanding ability of her/her classmates?	ABOVE 5	4	AVERAGE 3	2	BELOW 1	COMMUNICATION	☐
8. How does the student's vocabulary and word usage skills compare with those of other student s in his/her age group?	ABOVE 5	4	AVERAGE 3	2	BELOW 1		
9. How proficient is the student at telling a story or relating happenings from home when compared to classmates?	ABOVE 5	4	AVERAGE 3	2	BELOW 1		
10. How often does the student volunteer information to class discussions or in answer to teacher questions?	FREQUENTLY 5	4	OCCASIONALLY 3	2	NEVER 1	CLASS PARTICIPATION	☐
11. With what frequency does the student complete his/her class and homework assignments within the time allocated?	ALWAYS 5	4	USUALLY 3	2	SELDOM 1		
12. After instruction, does the student have difficulty starting to work (looks at other students working or asks for help)?	NEVER 5	4	OCCASIONALLY 3	2	FREQUENTLY 1		
13. Does the student demonstrate any behaviors that seem unusual or inappropriate when compared to other students?	NEVER 5	4	OCCASIONALLY 3	2	FREQUENTLY 1	SCHOOL BEHAVIOR	☐
14. Does the student become frustrated easily, sometimes to the point of losing emotional control?	NEVER 5	4	OCCASIONALLY 3	2	FREQUENTLY 1		
15. In general, how would you rank the student's relationship with peers (ability to get along with others)?	GOOD 5	4	AVERAGE 3	2	POOR 1		