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ORIGINAL ARTICLE

Importance of Pre-Educational and Post-Educational Language Tests and Effect of Training on the Diagnosis of Auditory Processing Disorders (APDs) in Children

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Objective: Aim of this study was to evaluate the importance of pre-educational and post-educational language tests for childs with language problems and effect of training on the diagnosis of auditory processing disorders (APDs). We used "Synchronously-understanding the Unplanned Event through its Picture and Listening" (SUEPL)-Training Method.

Materials and Methods: The study consisted of 10 childs, referred with the suspect of APD. There was expressive language delay (DEL) in eight childs (8 boys). Their receptive language development and intelligence levels were normal. In 2 childs (1boys, 1 girl), expressive and receptive language developments were in normal levels; but there were additional problems such as listening problems and attention disorders. The training method of SUEPL was applied to the childs. After the education with SUEPL, symptoms of APD were evaluated and reported in these 10 childs, in pre- and post-SUEPL-training periods. Difference between pre-educational and post-educational receptive language levels were analyzed by "Chi-Square Test".

Results: The childs' pre-educational language development levels showed that only in childs 1 and 2, language development levels was normal. Receptive language levels were normal in all childs. Expressive language delay was present in childs 3-10. The difference between pre-educational and post-educational receptive language levels was not significant (p= 0.140, X2=2.180). Post-educational expressive language levels were significantly higher than pre-educational expressive language levels (p=0.001, X2=10.236) by SUEPL training method. Although language and additional problems were improved by training with the SUEPL-method, some symptoms of APD were not ameliorated by training; and studies for differential diagnosis should continue after training.

Conclusion: Our study may help to make differential diagnosis for APD. In children, suspected of APD, tests should be performed before and after training by SUEPL. SUEPL training method causes an improve in "bottom–up " processing by increasing input introduce and sound driven. As training is going on in natural life, the childs'understanding rapid or degraded speech also increases. By the help of these clear inputs, acoustic input processing may be improved.

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Introduction

Auditory processing disorder (APD) is a label that has become increasingly popular in recent years to describe a variable set of symptoms that have in common a difficulty listening to sounds in the absence of an audiometric deficit [1]. What makes the assessment of auditory processing so complex is that auditory processing disorders (APD) is not considered a "unitary" disorder that is easily isolated and targeted for treatment. Rather, it is a "set of symptom descriptions" and these symptoms overlap considerably with symptoms associated with a variety of other disorders including developmental language delays, specific learning disabilities (especially in the area of memory), and attention deficit–hyperactivity disorder [2].

Diagnosis is very complicated because of other types of childhood disorders may exhibit similar behaviors. Within the past 10 years, Cacace and McFarland [3] have contended that current central auditory processing tests are invalid because they cannot disassociate central auditory processing disorder (APD) from language, attention, and other problems [3]. Keith [4] has contended the test in question is sensitive to other processing demands. It is not correct to apply the label APD to these children, even if many of their behaviors appear very similar to those associated with APD. These additional processing abilities can greatly influence how a child's auditory system scans. It is necessary to view it as a discrete entity, apart from other childhood problems. If such reporting is not available, it is very difficult to interpret central auditory test results with any degree of reliability.

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We often see children with some discrepancy between the performance and verbal IQ. But, the auditory-language approach to assessment is clearly not auditory specific. Therapeutic interventions allow us to identify the auditory deficits present in children with APD who exhibit auditory perceptual problems that coexist with other processing problems.

Aim of this study was to evaluate the importance of pre-educational and post-educational language tests for childs with language problems and the effect of training on the diagnosis of auditory processing disorders (APDs). We observed the symptoms of Auditory Processing Disorders and evaluated whether these symptoms can be distinguished from other language problems and attention disorders by the help of the "Synchronously-understanding the Unplanned Event and its Picture through Listening" (SUEPL)-Training Method.

Material and Methods

The study was assessed in Kırıkkale University Faculty of Medicine ENT Department and Hacettepe University Faculty of Medicine, Division of Audiology and Speech Pathology of ENT Department. All steps of the study were planned and continued according to the principles outlined in the Declaration of Helsinki [5].

Subjects

The study consisted of 10 childs, referred with the suspect of APD. These children had normal hearing, general development and intelligence levels; but they had language and other problems. According to the hospital files: during their first year of life: One child had a febrile convulsion. In the others history, there was not any important chronic or acute diseases, causing language problems.

These 10 childs were applied language tests, and their language development levels were assessed. There was expressive language delay in eight childs (8 boys). Their receptive language development and intelligence levels were normal. In 2 childs (1 boys, 1 girl), expressive and receptive language developments were in normal levels; but there were additional problems such as listening problems and attention disorders.

The training method of "Synchronously-understanding the Unplanned Event through its Picture and Listening" (SUEPL) was applied to the childs. After the training with SUEPL, language tests and symptoms of APD were evaluated again in these 10 childs, in post-SUEPL-training periods.

Method

1. Before training by SUEPL-Method: The symptoms of 10 childs, referred with the suspect of APD, were recorded by a child development specialist, an educational audiologist who was also a child development specialist, before education. To see the impact of the auditory language disorder or other problems on daily life, the families also observed and reported the children's behaviors in written form.
2. These 10 childs were applied language tests, and their development levels were assessed. Language tests included auditory attention, listening, immediate memory-retrieval, language representation, long memory-retrieval, learning new words and grammar [6].

Evaluation of Language Development:

A- Preschool Language Scale-4 (Receptive and Expressive Language Test) [7]*:*

In childs, aged to 6 years and 11 months, language development levels were evaluated based on Preschool Language Scale-4 (Receptive and Expressive Language Test) [7]. The receptive and expressive language level of each child was assessed via Turkey Preschool Language Scale, Fourth Edition (TPLS-4) test. It consists of two subscales: Auditory Comprehension (AC) and Expressive Communication (EC). The AC subscale evaluates a child's ability to understand spoken language. Sixty-two AC tasks and 68 expressive communication tasks make up the total scale, and each may include one or more sub-items. Administration time varies, depending on the child's age and his/her cooperation during the test (mean: 20-45 min). Response scoring was as follows: passing an item required a score of "1" and not passing, a score of "0." Scores of "1" were summed for each subscale to yield an AC and an EC raw score. This study used the age equivalents. A language development level equal to or above the expected for the specific chronologic age was accepted as "normal", and otherwise as "delayed" for all groups of I to V.

Each child's receptive and expressive language levels were evaluated by Preschool Language Scale-4 test.

B. Clinical evaluation of language fundamentals, fourth edition (CELF-4) [8,9].

In childs, aged over than 6 years 11 months, language development levels were evaluated based on Clinical evaluation of language fundamentals, fourth edition (CELF-4) [8,9]. By this test, language development of the childs was screened in the view of whether it was normal or not. The results were given as "passed" or "failed".

3. Before education, with the help of language tests and observations of the educational audiologist, child development specialist and Childs' families, early symptoms related to APD suspicion were evaluated based on following parameters:

A-Listening problems, difficulty in auditory discrimination, difficulty in learning the words, selective listening, expressing the whole sentence with two or three words, to understand the given speech repeated a couple of times, to say a lot syllable words and long sentences, learning disabilities, unintelligent speech but with adequate vocal inflection and gestures, blabbering with a meaningful expression, repeating back what heard, comprehension, small vocabulary compared to peers, difficulty in repeating words, poor grammar usage, difficulty with remembering names and places, phonological or articulation disorders, etc.

B-Social/emotional behaviors: inattentive, very active, attention deficit disorders with or without hyperactivity, excessive talking, lacks of motivation, lacks of self-confidence, easily upset by new situations, tires easily, problems with the books, obstinate, sometime impulsive, talking less than peers, focused on television, etc.

4. *SUEPL-Training Application:* The training method of "Synchronously-understanding the Unplanned Event through its Picture and Listening" (SUEPL) was applied to these 10 childs, suspected of APD.

In SUEPL method, the family draws a picture of the actual event that is experienced at that moment. These are spontaneously occurring events which are un-planned. Pictures are shown to the child while asking the question appropriate to the word one wanted to teach. Question about the picture was answered other than the child. Child only listened to the answer. Every day, question is asked to other person by showing the drawn picture with the intervals of 1-2 hours or more. Child listened to the answer. Asking procedure went on until the answer is taken from the child by self. When making sure about the child's learning the word, picture is teared. The number of daily drawn pictures depends on the child's age and learning performance. At first, 5-10 words per day; then 10-20 words; later 20 - 30 words. children who received SUEPL training began to improve their expressive speech in 6 months (ranged 4 to 8 months) with a learned word number of 200 (range 150 to 250 words). Normally developed speech was achieved within 13 months (ranged 8 to 18 months) with a learned number of 375 words (range 250 to 500 words).

It was thought that the new training method for speech and language delay "Synchronously-understanding the Unplanned Event and its Picture through Listening" (SUEPL) was an effective method to improve language and speech in a short time. With this method, children learn the words related to everyday life more quickly. As they know which words to use (word retrieval) in the event or condition they encountered in daily life, their communicating with speech skills increased. In conclusion, with this training method of SUEPL, the plasticity of the auditory system may be increased with the help of continuous stimuli. Therefore, children may be able to understand the ongoing speech at that moment, they heard; and may be able to continue mutual conversation; and use pragmatic language in daily life.

5. Re-evaluation of the childs after training by SUEPL-Method with the help of Language Tests and observations: The evaluation described above was re-performed again after the SUEPL-training application. Childs' post-training language development levels were evaluated again by Preschool Language Scale-4 (Receptive and Expressive Language Test) [7]; or Clinical evaluation of language fundamentals, fourth edition (CELF-4) [8,9].

Statistical analysis:

Statistical packet for SPSS (Version 9.0) was used for statistical evaluation. The difference between pre-educational and post-educational receptive language development levels; and pre-educational and post-educational expressive language development levels were analyzed by "Chi-Square Test".

p value < 0.05 was considered as statistically significant.

Results

Demographic information; and pre-educational and post-educational receptive and expressive language development levels of children are given on Table 1. By the evaluation of the childs pre-educational language development levels, in childs 1-2, language development levels were normal. Receptive language development levels were normal in all childs (childs 1-10). Expressive language delay was present in childs 3-10 (Table 1).

Before SUEPL-Training period, Language Test Results: According to language test results, we found expressive language delay (DEL) in the 8 boys. Their receptive language development and intelligence levels were normal. In 2 childs (1boys, 1 girl),

expressive and receptive language developments were in normal levels; but there were additional problems such as listening problems and attention disorders (Table 1).

The eight childs in DEL group; and 2 childs in normal language group, having additional listening and attention problems was given SUEPL training method for mean:1year and 5 month duration.

After SUEPL-Training period, Language Test Results: After SUEPL-training was given to all of the 10 childs, symptoms "associated" with APD was observed in 6 (5 boys and 1 girls) childs (Cases 2,4,6,7,8,9). After training, children's behavioral features, associated with APD symptoms are presented in Table 2 [10,11].

In childs, having expressive language delay before training (Cases 3-10), although there were normal language expression after training in cases 4, 6-9; symptoms associated with APD were observed (Table 2). In case 2, language tests was normal before and after education, but the symptoms (listening problems and attention disorders), associated with APD, were going on after the training. List of symptoms associated with APD, constituted after education, are presented on Table 2.

In three childs in DEL group (Cases 3,5,10); and 1 child in normal language group (Case 1) before training; language tests were normal after education; and there were no symptoms associated with APD. In these childs, it was understood that there were additional problems, other then APD, causing language problems:

- Pervasive developmental disorders (Case 3);
- Language –learning problem (Case 5);
- Attention deficit disorders without hyperactivity (Case 10). After training, his attention was improved by medical treatment.
- Only- phonological disorders, but these substitutes' words, listening problems and attention disorders (Case 1).

The results for statistical analysis:

The difference between pre-educational and post-educational receptive language levels were analyzed by "Chi-Square Test". The difference was not significant (p= 0.140, X2=2.180).

Post-educational expressive language levels were significantly higher than pre-educational expressive language levels (p=0.001, X2=10.236).

Discussion

APD may coexist with other disorders (e.g., attention deficit hyperactivity disorder [ADHD], language impairment, and learning disability), it is not the result of these other disorders [12].

In children with Auditory processing disorders (APD) many additional problems were accompanied when they first come to the clinic. Because of these additional problems, their performance in the tests was not their "actual" performance; and the real nature of the disease (in diagnosis) is misleading. Correct test results may be obtained just after the training period by SUEPL occurred. Because, by the help of the SUEPL training method, additional problems accompanied by are improved. However, the real nature of the problem related to APD is not corrected.

In the present study, the childs' pre-educational language development levels were evaluated that, in childs 1-2, language development levels was normal. Receptive language development levels were normal in all childs (childs 1-10). Expressive language delay was present in childs 3-10 (Table 1).

The difference between pre-educational and post-educational receptive language levels were analyzed by "Chi-Square Test". The difference was not significant (p= 0.140, X2=2.180). This result may easily be predicted, because the childs' receptive language levels have already been in normal levels before training.

In most of the childs (Childs 3-10), there were expressive language delay at pre-training period. Post-educational expressive language levels were significantly higher than pre-educational expressive language levels (p=0.001, X2=10.236) by SUEPL training method. This result indicates that, expressive language levels of the childs increased by SUEPL training method. In pre-training period, sounds were not perceived in their correct sequences. In running speech, small differentiations of the sounds can not be performed in temporal centers.

It was concluded that SUEPL training method caused to improve in "bottom–up " processing by increasing input introduce and sound driven. As training is going on in natural life, the childs' understanding rapid or degraded speech also increased. By the help of these clear inputs, acoustic input processing may be improved.

Table 1. Demographic information; and pre-educational and post-educational receptive and expressive language levels of children

Case	Gender	Before education: Age	History	Before education Language level	Education duration	After education:	After education Language level Age	Other Problems	Symptoms "associated" with APD
1	M	6 years and 11 months		Receptive Language: 6:6 to 6: 11 Expressive Language: 6:6 to 6: 11 Language: NORMAL	9 months	7 years 8 months	Receptive Language: 7:0 to 8: 0 Expressive Language: 7:0 to 8: 0 Language: NORMAL	Only, phonological disorders, but these substitutes words, listening problems and attention disorders	
2	F	3 years and 11 months		Receptive Language: 3:6 to 3: 11 Expressive Language: 2:0 to 2: 5 Language: NORMAL	2 months	4 years 1 months	Receptive Language: 4:0 to 4: 5 Expressive Language: 4:0 to 4: 5 Language: NORMAL		*
3	M	6 years and 4 months		Receptive Language: 6:0 to 6: 5 Expressive Language: 2:6 to 2: 11 Language: EXPRESSIVE LANGUAGE DELAY	2 years and 8 months	9 years	Receptive Language: 9:0 Expressive Language: 9:0 Language: NORMAL	Pervasive developmental disorders	
4	M	3 years and 8 months		Receptive Language: 3:6 to 3: 11 Expressive Language: 2:6 to 2: 11 Language: EXPRESSIVE LANGUAGE DELAY	1 months	3 years 9 months Language: NORMAL	Receptive Language: 3:6 to 3: 11 Expressive Language: 3:6 to 3: 11		*
5	M	5 years and 8 months	A febrile convulsion	Receptive Language: 5:6 to 5: 11 Expressive Language: 2:0 to 2: 5 Language: EXPRESSIVE LANGUAGE DELAY	1 years	5 years 9 months Language: NORMAL	Receptive Language: 6:0 to 6: 5 Expressive Language: 5:6 to 5: 11	Language–learning problem	
6	M	5 years and 6 months		Receptive Language: 5:6 to 5: 11 Expressive Language: 3:6 to 3: 11 Language: EXPRESSIVE LANGUAGE DELAY	1 years and 9 months	7 years 3 months Language: NORMAL	Receptive Language: 7:0 to 7:3 Expressive Language: 7:0 to 7:3		*
7	M	5 years and 5 month		Receptive Language: 5:6 to 5: 11 Expressive Language: 2:6 to 2: 11 Language: EXPRESSIVE LANGUAGE DELAY	1years and 3 months	6 years 8 months Language: NORMAL	Receptive Language: 6:6 to 6: 11 Expressive Language: 6:6 to 6: 11		*
8	M	6 years and 11 months		Receptive Language: 6:6 to 6: 11 Expressive Language: 3:6 to 3: 11 Language: EXPRESSIVE LANGUAGE DELAY	1 year and 5 months	8 years 4 months Language: NORMAL	Receptive Language: 8:0 to 8:4 Expressive Language: 8:0 to 8:4		*
9	M	6 years and 2 months		Receptive Language: 6:0 to 6: 5 Expressive Language: 2:6 to 2: 11 Language: EXPRESSIVE LANGUAGE DELAY	1 year and 10 months	7 years 12 months Language: NORMAL	Receptive Language: 7:0 to 7:12 Expressive Language: 7:0 to 7:12		*
10	M	8 years and 10 months		Receptive Language: 8:0 to 8: 10 Expressive Language: 2:6 to :2:11 Language: EXPRESSIVE LANGUAGE DELAY	3 years and 9 months	12 years 7months Language: NORMAL	Receptive Language: 12:0 to 12:7 Expressive Language: 12:0 to 12:7	Attention disorders without hyperactivity	

**Symptoms "associated" with APD Female (F), Male (M),*

Table 2. Behavioral signs of APD [10,11].

Receptive language normal or poor, expressive language skills delay or language normal
Inconsistent responses to auditory input
Difficulty following oral instruction because of distracted or inattentive
Although they can become attention, attention drifts
Poor listening skills
Problem: phonemic and phonological awareness
Problem: speech sounds distinguish; especially, similar speech sounds
Poor phonology, deficiencies in remembering phonemes and articulation problem, but these substitutes words
Difficulty learning the new words
Poor perceive a signal in which some of information is missing, needs repetition of directions or information
Poor understanding sentence with new words (unfamiliar word)
Poor thinking of (finding) the right word to say
Trouble talking with a group of people
They talks short, choppy sentences without conjunction
They are not comprehend the sentence with conjunction and long
Delayed response to verbal requests
Problem understanding speech in noise, hypersensitive to noise
Perceive speech or other sounds when another signal is present (similar speech signal or competing signal, especially when the soft or loud)
Uses poor grammar when talking
Difficulty with the prosodic features of speech
Uses loud voice
They have difficulties not only in stressful or competing listening conditions, but also in quiet or ideal listening conditions

Howard and Hulit [13] found the relationship between expressive language and central auditory processing and no significant correlations between SCAN and the language subtests. Stollman, et al. [14] found significant correlations between APD and receptive, expressive language. On the contrary Keith et al. [15] and Sanger et al. [16] found only significant correlations APD and expressive language. We observed that, APD's symptoms and other problems may be confused before education. But, after education, they are separated from language, attention, and other problems. These demands are not actual disorders, but are affected by listening disorders.

According to Moore, key to deficient is primarily a difficulty in processing non-speech sounds [1]. In this study, in children, suspected of APD were observed showing as similar findings. Sometimes, they can't be able to notice or separate speech sounds in spite of remark. As most distinctive, they can exclusively confuse alike sounds. But, it is ameliorated by training. In the present study, the training method was "bottom-up" (i.e., sensory and data driven) method. Because, "bottom-up" auditory processing may improve the transfer and communication functions. "Bottom-up" training may support the transfer of special neural code to auditory processing system. Our ideas are suggested by the other researchers [12]. They believed that direct skills remediation, or auditory training, consists of bottom-up treatment approaches designed to reduce or resolve the APD.

Some researchers have begun to suggest that deficits in auditory processing are the most important key to understanding language –learning problems [17]. But, language –learning problems are improving by education. But entry of auditory input does not improve interhemispheric transfer of information, underlies binaural hearing and processing. Defining central auditory processing (CAP) as being bottom-up defines it as being data (sound) driven, with the properties of the data being the primary determinants of higher-level representations and constructions [18]. This is the approach taken by pathway models of auditory processing. Pathway models of auditory processing view the central auditory nervous system

(CANS) as the pathway that processes the auditory information. They focus on the evaluation of different levels of the CANS, and suggest that if testing is done in a controlled acoustic environment, then auditory processing can be separated from 'higher, non-auditory' factors such as attention, cognition, language, learning and memory [19].

It was reported that problems may occur while processing speech or non-speech sounds. Th6ere were observation of processing differences during training period. In expressive language delay group and normal group were seen APD before the patterns acquire labels. It was showed similarity between our observation finding and the clinical results [20,21]. As the noted Chermak and Musiek [22], comprehensive approach can be go well the functional plasticity of the maturing central nervous system and improving additional processing abilities or auditory processing skills. But, in this study, symptoms of APD can not be able to be ameliorated. They may be ameliorated in the future because of maturational effects. In "bottom-up" training, competing listening and interhemispheric transfer using inter-aural temporal off-sets and intensity differences are studied mainly.

We observed most of similarity between the signs of symptoms of APDs in Turkish children and by Keith list and Chermak at all, except that some items. The most manifest found item: ["they have difficulties not only in stressful or competing listening conditions, but also in quiet or ideal listening conditions"]. Smoski, et al. [23] found similar results. According to observations, key to deficiencies of APD is consisted of primarily a difficulty in processing speech sounds or non-speech sounds, including long sentences and/or sentences with conjugations. Because, these childs can understand with more repetition. Timing disorders with distorted emotio-motivational difficulties in time of the speech sounds processing may possibly be seen. And also, all of the systems, such as an orchestra, may not participate the processing at the same time, causing delay.

For example, in children with suspected APD, even though language is corrected, the problems of spreading the attention to all ongoing conversation and receiving instant messages and responding, continue. Because, during training, there is a delay in speech sounds processing when long sentences are established. If you split the long sentences, there is not understanding problems. These observations may point that APD contains difficulties in processing time of speech sounds. In the present study, auditory processing differences can be clearly seen before training. After training, better results in auditory processing may help the differential diagnosis of APD.

We concluded that observations during training may help to differentiate the normal and abnormal activities in the central auditory mechanisms. APD cannot be diagnosed from a symptoms checklist. No matter how many symptoms of APD a child may have, only careful and accurate diagnostic testing can determine the underlying cause. Therefore, listening behaviors and/or performance on tests of auditory functions may help to determine the nature and type of disorder. At the end, multi-disciplinary screening process should be performed for the approach to children, suspected of APD.

Our study may help to make the differential diagnosis for APD. In children, suspected of APD, tests should be performed before and after training by SUEPL. SUEPL training method causes to improve in "bottom–up "processing by increasing input introduce and sound driven. As training is going on in natural life, the childs' understanding rapid or degraded speech also increases. By the help of these clear inputs, acoustic input processing may be improved.

Conclusion

We observed that symptoms of APD and other problems are likely to be confused with other language problems, if the childs were not in training programmes. But, additional problems were ameliorated by training. Therefore, symptoms may be observed during and after education. After education, APD is not confused with language, attention, and other problems. These observations may help for the diagnostic tests of APD. Also, results of training must be evaluated by multi-disciplinary approach.

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