Utility of the 'Screening Checklist for Auditory Processing' (SCAP) in Detecting (C) APD in Children

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Certificate

This is to certify that this dissertation entitled "Utility of the 'Screening Checklist for Auditory Processing' (SCAP) in Detecting (C)APD in Children." is a bonafide work in part of fulfillment for the degree of Master of Science (Audiology) of the student Registration no: 07AUD011. This has been carried under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any diploma or degree.

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Certificate

This is to certify that this dissertation entitled "Utility of the 'Screening Checklist for Auditory Processing' (SCAP) in Detecting (C)APD in children" has been prepared under my supervision & guidance. It is also certified that this dissertation has not been submitted earlier to any other university for the award of any diploma or degree.

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Declaration

This is to certify that this master's dissertation entitled "Utility of the 'Screening Checklist for Auditory Processing' (SCAP) in Detecting (C)APD in Children" is the result of my own study under the guidance of Prof. Asha Yathiraj, HOD (Dept. Of Audiology), All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other university for the award of any degree or diploma.

MYSORE

May, 2009. Registration No: 07AUD011

Dedicated to

My Father Lord Jesus

And My Dearest Amma

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Before you finish praying, I will answer to your prayers

-Isaiah (65:24)

I thank the almighty God - *for He was the beginning and end of what I do and say and prompts my action and complete them all with all with His powerful help.*

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To me…you were warble tones, saving me from standing waves….

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INTRODUCTION

A (Central) auditory processing disorder [(C) APD] has been defined as a deficit in the processing of auditory information, despite normal hearing threshold (ASHA, 2005; Jerger & Musiek, 2000). According to ASHA (2005), the (Central) auditory processes include the auditory mechanisms that underline several abilities or skills. These include sound localization and lateralization, auditory discrimination, auditory pattern recognition, temporal aspects of audition such as temporal integration, temporal discrimination (e.g. temporal gap detection), temporal ordering, temporal masking, as well as auditory performance with degraded acoustic signal. Deviancy in any of these skills has been noted to result in a (C) APD. Dawes and Bishop (2007) reported that this deviancy in turn could bring about listening difficulties which would result in academic, behavioural, and social difficulties.

The effect of (C) APD on academic abilities has been well documented in literature. Early identification and appropriate intervention is crucial to academic success. According to Chermak (1996), screening is important to allow timely intervention. This would minimize the distress and maximize the communicative, educational, and social function.

Northern and Downs (1991) defined screening as "the process of applying certain rapid and simple tests, examinations or other procedures to, generally, a large number of populations that will identify those persons with high probability of a disorder from those persons who probably do not have the disorder" (pg . 259). As with other condition, screening tools to identify (C) APD have been designed by several researchers.

Musiek, Gollegly, Lamb and Lamb (1990) listed several reasons as why screening for (C) APD should be carried out. A major reason was to enable in early identification, thus, allowing insight into educational planning and effective management strategies. They noted that screening also helped in identifying conditions leading to (C) APD that may require medical attention. It was also noted that screening promotes increased awareness of (C) APD among educators and parents. Further, they reported that it helps in easily determining the cause of a particular child's listening and learning difficulties and hence, minimized the psychological factors like anxiety and stress in the child. Bellis (2003) added that screening for (C)APD could help in providing direction to special educators, speech language pathologists, rehabilitative audiologists, and others entrusted in the task of developing remedial programs and hence help in managing disorders of children more effectively.

Screening for (C) APD has been carried out using checklists and / or tests. Both procedures have been reported to have their own advantages and disadvantages. Information gathered from checklists and questionnaires have been suggested to be used to identify children at-risk for (C) APD and also provide insight regarding functional deficits and program planning (ASHA, 1996; Fisher, 1976, cited in Willford & Burleigh, 1985; Smoski, Brunt & Tannahill, 1992). The screening checklists have been noted to be cost effective and time efficient. It has been emphasized by Lessler (1972, cited in Bellis, 2003) that this is an important component in a screening process, because screening usually entails dealing with a larger number of individuals. On the other hand, according to Emerson, Crandell, Seikal and Chermak (1997), using checklists for screening can lead to over-referral due to the presence of children with disorders having overlapping symptoms. Some of the checklists reported in the literature are Children's Auditory Processing Performance Scale (CHAAPS), and the (Smoski, 1987, cited in Smoski, Brunt & Tannahill, 1992), Screening Checklist for Auditory Processing (SCAP) (Yathiraj & Mascarenhas, 2003) and 'Fisher's auditory performance checklist' (Fisher, 1976, cited in Willeford & Burleigh, 1985).

Unlike those who recommended the use of screening checklists, Schow and Seikal (2007) recommended that screening tests be used to refer children for further (C) APD evaluation. Screening tests are reported to be efficient by Schow and Seikal (2007), if they assess most of the auditory processes. However, Emerson et al., (1997) reported that screening tests require an acoustically noise-free environment and more time to administer, thus making them difficult. Some of the widely used screening tests included the Screening Test for Central Auditory Processing for Children (SCAN-C) by Keith (2000), Screening Test for Central Auditory Processing for Adults (SCAN-A) developed by Keith (1995) and Selective Auditory Attention Test (SAAT) by Cherry (1980, cited in Chermak, Styler & Antony, 1995).

According to Bellis (2003), one way to reduce over-referral when screening for (C) APD is through the use of a team approach. This was noted to help gather information about various aspects of a child such as listening behaviours, educational, social, speech / language, cognitive, and medical characteristics.

Bellis (2003) cautioned that prior to the referral for a comprehensive central auditory assessment, it should be ascertained that sufficient assessment of cognitive, speech/language, and related abilities have been performed. This is to ensure that the child has the capacity to participate in the assessment procedure. Such a detailed evaluation, prior to testing, would also add sufficient additional information to the child's educational picture and hence justify the time and effort spent in such a procedure.

Similar to what is recommended for other condition, those suspected to have (C)APD based on screening procedures, would require to be evaluated using diagnostic tests. Both screening and diagnostic test procedures have been noted to play a role in assessing central auditory processing system (Musiek et al., 1990). However, Chermak (2001) reported that these screening tools have often been misused to identify (C)APD rather than to refer for further detail assessment. Hence, it was emphasised that screening tools should be used to refer individuals with symptoms of problem for comprehensive assessment and not to be used to label or identify the problem. This had been emphasized earlier by Chermak and Musiek (1997).

Validity and reliability of a screening procedure needs to be studied to know how effectively they can be used in a clinical set-up. The ASHA task force (2005) recommended that a test battery approach should be used to check for the efficiency of screening checklists and tests. Although, a variety of methods to assess the Central Auditory Nervous System (CANS) are available, behavioural tests have been recommended to be used for the diagnosis of (C)APD in children or adults (Chermak, 1992). Chermak and Musiek (1997) reported that it is valuable to select tests that assess different processes rather than evaluate the same process. They highlighted that these behavioural assessment data would be used to guide the intervention planning.

From this information, it can be construed that both screening tests / checklist as well as diagnostic test are highly important in the ultimate management of individuals with (C)APD. The first stage in identifying the presence of a (C)APD, is the use of a screening test / checklist. Hence, it is essential that screening tests / checklists should be efficient with clear cut-criteria to decide whether an individual should be referred for further evaluation or not.

Need for the Study

According to Repp and Stockdell (1978), 15% to 20% of a school-age population have some type of language / learning disorder, out of which, 70% have some form of auditory impairment. However, Lewis (1986, cited in Bellis, 1996) estimated that only 3 to 7% of all school-age children exhibit some form of learning disability. Similar to the findings of Lewis, it was found by Cherry (1987) that 6.5 % of children in the age range 3 to 17 years have learning disabilities, with a high proposition of these children having (C)APD.   In India, it has been found that 3% of school-going children have dyslexia (Rama, 1985). A direct estimate of the number of school aged children with (C)APD was obtained by Chermak and Musiek (1997) who found it to be 2% to 5%.

As (C)APD is likely to influence the education of a child, a large number of them with the problem are likely to drop-out. This would especially happen if their problems go undetected or undiagnosed. Appropriate identification of children with (C)APD can assist not only in the development of effective management and educational strategies, but can also reduce or eliminate the stress that ensues from not knowing the underlying reason for learning disabilities.

In order to identify a child with a suspected (C)APD, an effective screening tool is required. For the tool to be efficient it should be tested on a large population and should have a clearly defined pass / refer criteria. Further, the sensitivity and specificity of the screening checklist or tests should be available so that its level of efficiency is known. Also checklists have added advantage of not being affected by the regional language. In a multi-linguistic country like India, it is far more easy to just translate a checklist into different languages without influencing the outcome of the findings, instead of developing screening tests in various languages.

Though, Schow and Seikal (2007) recommended the use of the screening (C)APD tests rather than checklists, the latter is known to have several advantages. Checklists are known to be much faster to administer as well as far less expensive. This is very essential in a country like India where the population is very high and finance is a constrain. Further, screening tests have been reported to have a higher level of sensitivity and specificity (Schow & Seikal, 2007) when compare to screening checklists. However, this is not always true. It has been reported that screening test for (C)APD such as SCAN (Keith, 1986; cited in Katz, 1995) have a sensitivity of only 45% and specificity of 95% as reported by Domitz and Schow (2000). In addition, the need for trained professionals and specific equipment / environment would deter their use. In contrast, a checklist could be used by any allied professional / personal, with basic educational levels, in any environment with no special equipments.

In India, the SCAP (Yathiraj & Mascarenhas, 2002) has been utilized to detect the presence or absence of (C)APD in children effectively (Yathiraj & Mascarenhas, 2003; Devi, Sujitha & Yathiraj, 2006; Priya & Yathiraj, 2007; Maggu & Yathiraj, 2007).

Yathiraj and Mascarenhas (2003) found no significant difference in the results obtained between SCAP and (C)APD diagnostic tests. The others (Devi & Sujitha & Yathiraj, 2006; Priya & Yathiraj, 2007; Maggu & Yathiraj, 2007) also found SCAP to be effective in detecting the presence of (C)APD in children. However, it has not been confirmed that children who pass the screening checklist do not have (C)APD. There is a need to confirmed whether those children who do not exhibit or exhibit (C)APD symptoms as per the screening checklist, also pass or fail diagnostic tests, respectively.

Aim of the Study

The study was carried out to achieve the following aims:

1. To use SCAP to identify children who have symptoms of central auditory processing,
2. To find the agreement of SCAP scores with a battery of (C)APD tests,
3. To determine an appropriate cut-off criteria for SCAP, and
4. To determine the sensitivity and specificity of SCAP

In order to determine the usefulness of screening checklists that have been published, a review of literature was carried out. Information was also obtained regarding the battery of tests that have been recommended to confirm the presence of (C)APD.

REVIEW OF LITERATURE

In view of early identification of (C)APD, the need for screening procedures has been stressed repeatedly in literature. Early intervention of children who are suspected to have (C)APD have been considered critical for academic success. It is recommended that a screening tool should address each of the auditory test domains specified by ASHA (2005). Screening for children at-risk for (C)APD can be completed by the audiologist in a manner similar to pure tone screening or alternatively may be done following referral by teachers, parents or other professionals. A number of checklists and screening tests have been developed over the years. There has been considerable debate whether screening checklists or screening tests are more appropriate in detecting the presence of (C)APD. The following section describes these two screening procedures, highlighting the changes that have ensued with the intention of bringing improvement in the procedures.

Screening checklists

Screening checklists have been developed based on the symptoms exhibited by children with (C)APD. Children who have (C)APD have been said to exhibit characteristics such as the following: deficits in the comprehension of speech in competing background noise, distractibility, reduced auditory attention, inconsistent awareness of auditory stimuli, poor concentration, and academic achievement lower than predicted by intelligence measures (Chermak & Musiek, 1992; Emerson, Crandall , Seikal &Chermak, 1997). Meyer (1975, cited in Willeford & Burleigh, 1985) reported that children with (C)APD manifest behaviours that include disruptive classroom pranks, asocial behaviours ranging from withdrawal to hostile aggressiveness, delinquency, and even social fantasies.

ASHA in 2005 reported that the sensitivity and specificity of a screening test may be derived from patients with known confirmed central processing dysfunction. Established behavioural tests were considered necessary to estimate the efficiency (sensitivity and specificity) of a screening procedure. According to the ASHA task force, efficiency refers to the test's ability to identify both the presence and absence of a disorder. This would enable clinicians to choose those procedures that have the greatest sensitivity and specificity.

Schow and Seikal (2007) opined that a screening instrument for (C)APD should identify a high proportion of those with the disorder, be relatively brief, easy to administer and be inexpensive. Further, they emphasised that the screening instrument should not be influenced by hearing loss, language, cognition, culture or other non-auditory factors. They recommended the use of behavioural methods for screening (C)APD that have a high sensitivity and specificity. They also advocated the use of questionnaires for screening (C)APD, as they provide good functional information of everyday problems. Further, they suggested that once a diagnosis is made, information from the questionnaire could assist in intervention, planning, counselling, as well as collaborating with parents or other professionals. The questionnaire could even contribute as an outcome measure across the course of therapy.

There are many screening checklists developed to screen for (C)APD based on symptoms. Fisher (1976, cited in Willeford & Burleigh, 1985) developed the 'Fisher's Auditory Problems Checklist' to help identified children with (C)APD. It was designed to be administered by teachers to identify children suspected to have (C)APD, based on a set of 25 questions involving academic performance and related behaviour. The questionnaire itemized behaviours such as failure to attend to oral instructions, the need for repeated instructions, and easy distraction by auditory stimuli. Further, the questionnaire had a preponderance of items that aimed at detecting language-based deficits (e.g: lack of age-appropriate comprehension of speech). Several questions in this questionnaire tapped the discrimination ability and degraded processing in a competing acoustic environment, which were addressed by ASHA (1996, 2005). Attentional and memory issues, not reflected in ASHA (1996, 2005) were included in the questionnaire. This checklist also had norms developed for children from kindergarten through sixth grade. However, Willeford and Burleigh (1985) reported, based on the finding of some school audiologist, that it gave high false-positive results.

Another checklist developed by Willeford and Burleigh (1985) involved a rating scale by which behaviours associated with (C)APD were numerically ranked. In 1985, Willeford and Burleigh reported that this checklist had not been utilized widely as its sensitivity, reliability, and validity had not been studied. Further, Smoski, Brunt and Tannahill (1992) criticized the two checklists developed by Fisher (1976, cited in Willeford & Burleigh, 1985) as well as by Willeford and Burleigh, mentioning that they did not focus on a specific observed listening behaviours of children with (C)APD. In addition, they also reported that the listed listening behaviours on these checklists were based on a limited number of subjects.

Sanger, Freed and Decker (1985) profiled the auditory behaviours of the children who were suspected to have auditory processing disorder using an informal 23-itemed checklist. They reported that some of the symptoms occurred more frequently in their participant. 70% of the children were inattentive, 65% of them were distractible and restless, 55% had difficulty in following instruction as well as showed inconsistent responses and 30% of them had difficulty in auditory memory.

The Children's Auditory Processing Performance Scale (CHAPPS) was developed by Smoski (1987, cited in Smoski, Brunt and Tannahill, 1992). It was designed to be administered on parents and teachers to assess the listening ability of a child. It had six listening categories and the parents / teachers were asked to make an assessment comparing their child to other children of a similar age. The listening categories include perception in the presence of noise, quiet, multiple inputs, auditory memory/sequencing and auditory attention span. The checklist had a total of 36 questions with each one rated +1 to -5. The higher rating (+1) indicated less difficulty while the lower rating (-5) indicated more difficulty. The total score ranged from +36 to -180.

Various studies have been reported in literature where CHAPPS has been used. This includes determining listening difficulties, reporting changes in listening behaviours following therapy, and comparing the finding with diagnostic tests. Smoski et al (1992) used CHAPPS to obtain the listening difficulties of 64 children who were identified as having (C)APD. These children were diagnosed to have (C)APD on the basis of failing two or more of a four tests comprised of the staggered spondee word (SSW) test and versions of the dichotic digits, competing sentence, and pitch pattern tests. The listening function of the children varied depending upon the listening condition and listening function being rated as per CHAPPS. They also found that the children with (C)APD showed difficulties not only in stressful or competing listening conditions, but in quiet or ideal listening conditions. The symptom that the children exhibited most often was difficulty in hearing in a noisy situation. This was followed by difficulty in auditory memory, listening in quiet situation, auditory attention and integration of multiple modality inputs and finally listening in an ideal condition. Further, the authors reported that 56% of their participant had poor concentration. However, 33% of the children performed at or above grade level in all academic areas, and only 55% of the children were enrolled in special academic programs. Smoski (1990) also recommended using CHAPPS as an objective tool to find out effectiveness of therapy.

Purdy and Jonstone (2000) found a significant correlation between the Dichotic digit test and memory rating with CHAPPS. However, Drake et al. (2006) found that CHAPPS lead to either over or under referral and that it could not be used as an isolated tool for referral.

Cameron, Dillon and Newalli (2005) compared CHAPPS with a battery of tests. The test battery included, Pitch Pattern Sequencing Tests (PPS), Duration Pattern Test (DDT), Masking Level Differences (MLD), Bamford-Knowal-Bench Sentences (BKB) and Random gap detection test (RGDT). The authors found that there was no correlation between CHAPPS and the (C)APD tests used by them. The authors concluded that the CHAPPS scores were not related to the magnitude of deficits evidenced by any of the tests. However, the checklist was thought to provide valuable information in assessing the overall auditory function.

A Screening Checklist of Auditory Processing (SCAP) was developed by Yathiraj and Mascarenhas (2003). It was developed based on the knowledge of speech and hearing professionals as well as several existing checklists. The checklist included the Fisher's Auditory Problem Checklist (Fisher, 1976, cited in Willeford and Burleigh, 1985), CHAPPS (Smoski, 1987, cited in Smoski, Brunt and Tannahill, 1992) and checklist available on the internet such as CAPD Symptoms and Subtypes Checklist (Paton, n.d) and the (C)APD checklist (The Speech, Hearing, Learning centre, Inc, Greenville, South Carolina). The SCAP was designed to be administered by parents or class teachers. It comprised of 12 questions regarding symptoms of (C)APD that included auditory perceptual processing, auditory memory and other miscellaneous symptoms. The checklist was scored on a two point rating as 'Yes' or 'No'. Each answer marked 'Yes' was scored '1' and each 'No' was scored '0'. Children who scored more than 50% (6/12) were considered to be 'at-risk' for (C)APD. The cut-off criterion was arbitrarily set high in order to increase the sensitivity of the checklist. Yathiraj and Mascarenhas (2003) found no significant difference between the results of SCAP and the diagnostic tests, including Dichotic CV, Speech-in-Noise Test (SPIN), Duration Pattern Test, Auditory sequence test, thus, substantiating its utility.

In India, the SCAP has been utilized to detect the presence or absence of (C)APD in children effectively (Yathiraj & Mascarenhas, 2003; Devi & Sujitha & Yathiraj, 2006; Priya & Yathiraj, 2007; Maggu & Yathiraj, 2007). Yathiraj and Mascarenhas (2003) found no significant difference in the results obtained between SCAP and (C)APD diagnostic tests. The others (Devi & Sujitha & Yathiraj, 2006; Priya & Yathiraj, 2007; Maggu & Yathiraj, 2007) also found SCAP to be effective in detecting the presence of (C)APD in children. However, it has not been confirmed that children who pass the screening checklist do not have (C)APD.

Simpson (1981, cited in Musiek & Chermak, 2007) developed the Scale of Auditory Behaviours (SAB) which consisted of two subscales, one to be used by teachers and the other by parents. Normative data for the SAB was established on 96 children between the age ranges of 4 to 6 years. Domitz and Schow (2000) validated the teacher's scale on 81 participants. Out of them, 17 were found to have (C)APD. Shiffman (1999, cited in Musiek & Chermak, 2007) reported that only 7 of the children in their study were identified as having (C)APD based on the SAB questionarie. On the other hand, 12 of their children were falsely suspected to have (C)APD.

The Children's Home Inventory for Listening Difficulty (CHILD) was a 'family-centred' checklist developed by Anderson and Smaldino (2000) for children aged between 3 years to 12 years. Parents were expected to assess their child's listening behaviour within the home environment. The item in the checklist included difficulty in hearing and comprehension in quiet and noisy situation, checking some of the specific auditory processing abilities. It was found to broadly screen for (C)APD.

Chermak, Somers, and Seikal (1998) developed a questionnaire to differentiate ADHD from the (C)APD. The questionnaire listed symptoms used by the various professionals including speech pathologists, paediatricians and audiologists to discriminate these two disorders. The utility of this questionnaire was however not provided.

Other checklists reported in literature include Evaluation of Classroom Listening Behaviours (ECLB) by VanDyke in 1985 (cited in Musiek & Chermak, 2007) and the Screening Instrument for Targeting Educational Risk (SIFTER) by Anderson (1989, cited in Katz, 2002). These checklists have been designed specifically to identify listening and academic problems in an educational setting. These questionnaires included some specific (C)APD symptoms related to classroom listening abilities that have been considered to be useful in screening for the disorder in a broader spectrum.

From the literature, it is evident that several checklists / scales have been developed. Though researchers have utilized some of them, few of them specifically report the sensitivity and specificity of the checklists.

Besides checklists, screening tests have been recommended to detect the presence of (C)APD in children. The following section discusses the screening tests that have been reported in literature.

Screening Tests

Chermak and Musiek (1997) suggested that children at-risk for a (C)APD would have to be screened using a battery of tests or a single test to find out if they have a problem. One of the earliest screening tests that was developed is the ‘Selective Auditory Attention test’ (SAAT) developed by Cherry in 1980 (cited in Katz, 2002). It was designed to identify young children (aged 4-8years) who had selective attention deficits, which was thought to interfere with academic achievement. SAAT, a closed-set word-identification test, used commercial recordings of the Word Intelligibility by Picture Identification (WIPI) test (Ross & Lerman, 1971, cited Chermak, Styer & Seikel, 1995). The SAAT involved diotic, sound field administration of two lists of the WIPI. One list was required to be presented in a quiet condition and one in a competing background using a story. The performance on the list presented in a quiet condition was reported to assess auditory discrimination, while the performance on the list presented in the presence of competing background, reflected selective auditory attention ability.

Cherry (1980, cited in Chermak, Styler & Seikal, 1995) determined the validity of the SAAT based on the performance of 321 children aged 4-8 years. The SAAT correctly identified 90% of the children with learning disability and 40% of the children judged by teacher as being ‘at-risk’ for learning problem. However, 13% normally achieving children were incorrectly identified as being ‘at-risk’ for learning problems.

A frequently used screening test battery for auditory processing disorders is the SCAN, developed by Keith (1986, cited in katz , 2002). It was designed for use with children aged 3 to 11 years. The SCAN involved administration of three sub tests which included auditory figure ground (AFG), filtered words (FW), and competing words (CW). The children were required to repeat the stimulus heard by them. The SCAN was standardized on a sample of 1034 children from a variety of geographic regions and racial and economic groups (Keith, 1986).   Keith (1989, cited in Chermak, Styer &Seikel, 1995) reported that SCAN could be used conveniently in school situations, since it required only a portable cassette player with headphones. However, it was necessary to administer the test in a quiet environment which took around 20 minutes.

Keith, Rudy, Donahue and Katbamma (1989) found a positive but weak correlation between the SCAN subtests and general measures of language. They reported this as evidence that the SCAN is a valid measure of auditory processing. The authors reasoned that they did not find a high correlation with general measures of language because the SCAN is focused on specific auditory processing ability. However, they also reported that the SCAN was sensitive to the presence of an Attention Deficit Hyperactive Disorder (ADHD). This has been criticized by Stach (1992) who reported the SCAN was "uncertainly sensitive" to (C)APD. Rather, they found SCAN to be more sensitive to the presence of attention deficits and language problems. Further, SCAN was criticized by Bellis (1996) and Schow and Seikal (2007) for the tests included in it. Though, SCAN used a battery of tests, it included only two of the screening test areas listed by ASHA (2005). The two test areas included were binaural / dichotic tests and monaural low redundancy tests. Bellis (1996) criticized SCAN as it did not include a temporal processing measure.

Further, issues regarding the scoring procedure, the environment and the test-retest reliability of SCAN have also been raised. The test-retest reliability of the SCAN was noted to be relatively low as reported by Amos and Humes (1998) when the test was administered after a 6-7 week interval. They found that the highest test-retest correlation was moderately strong for the competing word subtest and composite scores ($0.70 < r < 0.78$). Humas, Amos and Wynne (1998) criticized the scoring procedure used in the SCAN, noting that it did not provide equal weighting for each subtest while computing the composite score. Emerson et al. (1997) found that SCAN scores obtained in a school situation were considerably poorer compared to that obtained with audiometric test conditions. To overcome all above criticism, the SCAN test was revised and two separate tests were developed, SCAN-A (Keith,1995) for adults and SCAN-C (Keith, 2000) for children.

SCAN-A for adults and adolescents above the age of 12 years was developed by Keith in 1995. The standardized version of SCAN-A included six sub tests: two filtered words, two auditory figure ground tests and competing words and sentences. Keith (1995) reported that the test-retest reliability of SCAN-A was found to be 0.69, indicating good reliability.

The SCAN-C for children (Keith, 2000) had the following in addition made to the original SCAN: A CD version was made available, competing sentences were included, and equal weighting was given to all subtests when deriving the composite score. It was standardized on children ages between 5 to 11;11 years.

Chermak, Styler and Seikal (1995) compared the two screening tests, SCAN and SAAT. The composite score of SCAN and the SAAT score provided equivalent group means. However, the SAAT identified a greater number of children as 'at-risk' for (C)APD. The SAAT scores were consistently lower than that of the SCAN and in most cases (90%) agreed with parental reports of attention deficits. They observed that SAAT and SCAN measured different but overlapping aspects of auditory processing and that the two screening tests did not consistently identify the same children as 'at-risk' for (C)APD.

In addition to SCAN, Keith (1994, cited in Bellis, 2003) also developed a screening tool 'The Auditory Continuous Performance Test' (ACPT). This screening test looked at only attention related auditory behaviours. The test assessed auditory vigilance, which required listeners to attend to strings of monosyllable words, and to raise their thumbs whenever those particular words occurred. Both impulsivity and omissions errors were scored, and performance at the beginning and at the end of the test were compared to provide an indicator of auditory vigilance over time. This provided information about the child's ability to sustain attention to auditory stimuli.

Quick SIN and BKB SIN were developed by Etymotic research (2001, 2005) to assess an individual's ability to listen in the presence of background noise. Theses tests were designed to rapidly provide a reasonable estimate of the functional signal-to-noise ratio at which individuals were able to comprehend speech.

A performance-intensity function for phonetically balanced words (PI-PB) has been proposed as a means of testing monaural low-redundancy processing in the elderly (Humes , 2005). However, the test was expected to reveal deficits in individuals in whom greater redundancy was required. Earlier, Jerger (1981) reported that PI-PB test could be used to detect children having either brainstem or cortical auditory processing dysfunction. The principle behind this test was that the performance-intensity function improved dramatically as intensity increased. Humes (2005) examined the utility of the test in individuals with auditory processing problems and obtained equivocal results. Since this test could be administered easily using standard audiometer without any special requirement, it can serve as a potential screening instrument.

Bellis (1996) suggested using some speech-language and psycho-educational tests in addition to the standard audiological screening tests, as they provide some information about the auditory abilities of the child. The tests include the Token Test (DiSimoni, 1978), Lindamood Auditory Test of Conceptualization (Lindamood & Lindamood, 1971), Flowers-Costello Tests of Central Auditory Abilities (Flower, Costello, & Small, 1973), Auditory Discrimination Test (Raynols, 1987), and Goldman, Fristoe, Wooodcock Auditory Skills Test Battery (Woodcock, 1976). However, Chermak and

Musiek (1997) reported that all these tests have drawbacks including heavy language dependency, possible visual cuing, poor acoustics and lack of any derived laterality information.

Chermak (2001) recommended that a screening tool should consider both sensitivity and specificity for it to be used in a clinical situation. However, most of the screening questionnaires and screening tests have a low sensitivity.

From the literature it is apparent that screening test could be employed to screen for the presence of (C)APD. These tests are reported to identify the children who are 'at-risk' for (C)APD to some extent. However, none of the screening tests included different tests to assess most of the auditory processes. To overcome the disadvantages of screening tests not providing information regarding most of the auditory processes and to increase the sensitivity, hybrid screening procedure was developed. The literature on hybrid (C)APD screening are discussed in the following section.

Though there are several screening tests that have been developed, very few of them provide information about their sensitivity and specificity. The few tests that do provide this information have far from desirable sensitivity and specificity. To overcome this problem hybrid (C)APD screening tests have been developed.

Hybrid screening

Domitz and Schow (2000) used a four-test battery, two questionnaires, the SCAN and auditory fusion tests - Revised (Keith, 2000) on 81 children. The four subtests included were monaural selective auditory attention test to assess monaural separation/

closure, Pitch pattern Test (PP) to evaluate temporal processing, Dichotic digits (DD) and competing sentences (CS) to measure for the binaural integration process / separation. Seventeen of the 81 children failed the screening on at least one of the four tests and were diagnosed to have (C)APD. The reason for using a combination of tests and the questionnaires was because most screening tests such as SCAN, SCAN-C were questioned regarding their validity as they did not assess some of the auditory processes (Bellis, 1996; Schow & Seikal, 2007).

Later, Schow, Chermak, Seikal, Brockett and Whitaker (2007) proposed a hybrid screening test which included the Multiple Auditory Processing Disorder (MAPA) test that assessed most of the auditory processing domains to be used along with the SAB questionnaire. In 1999, during the development of MAPA, Shiffman (1999, cited in Schow et al., 2007) utilized the combination of the four-test battery screener and a questionnaire. The combination resulted in the sensitivity being 83% and specificity being 85%.

The authors' rationale for selecting multiple tests as described by ASHA (1996, 2005) for screening was to achieve greater sensitivity. However, it was felt that it would reduce the specificity leading to over-referral. However, the authors opined that the cost involved in further diagnostic testing due to over-referral would be less than the failure to identify the problem earlier. Thus, it was accepted that the screening tests could lead to over-referral, with the aim to increase sensitivity (Schow & Seikel, 2007).

A modified version of the test by Schow et al. (2007) added a new subtest to the existing four subtests, i. e MAPA TAP test to assess the temporal process. The MAPA was developed to identify children and adults who had auditory processing disorders, from at 8 years of age onwards. Supplementary tests were also available under MAPA. They were MAPA Durations Pattern Test (MAPA DPT), MAPA Speech-in-Noise for Children and Adults (MAPA SINCA) and MAPA Fusion Test (MAPA AFT-R).

The authors claimed that the administration duration of the MAPA screening tests was around 21minutes. Schow et al. (2007) also suggested using the Scale of Auditory Behavior (SAB) along with MAPA and referred it to it as a hybrid screening technique to check if there was any co-morbid with Attention Deficit Hyperactivity Disorder (ADHD), Learning Disability (LD) and autism disorder.

The sensitivity and specificity of MAPA has not been established on individual with confirmed lesions in the CANS (Schow & Seikal, 2007). The results of MAPA were compared with behavioural diagnostic tests. Based on the finding obtained from diagnostic tests, Domitz and Schow (2000) recommended that individuals should be referred for detailed evaluation if the performance on any of the tests was less than two standard deviation. Summers (2003) also suggested that those children who failed the questionnaire, but passed the test should be followed-up and retested again after a year.

The test-retest reliability of the MAPA on 7 children in the age range 8-11years was determined by Domitz and Schow (2000). The authors reported that the test-retest reliability was good ($r = 0.89$). Similarly, Summers (2003) was also reported a fairly high test-retest correlation between the two sets of tests. The correlation for the different tests within the battery was fairly high (PP = 0.91, CS = 0.86, TAP = 0.77, DD = 0.73, and MSAAT = 0.67). These findings confirm that the MAPA tests met the generally accepted standard of reliability, which is $r > 0.7$.

It is essential that those who do not pass a screening checklists or screening tests be referred for further detailed evaluation. However, there is considerable debate regarding the choice of tests that should constitute the battery of tests that should be administered to confirm the presence of the (C)APD. The following section discusses this.

Test battery approach for diagnosing (C)APD

The efficiency of a screening test has been determined based on its sensitivity and specificity (Schow & Seikel, 2007). This has been considered possible by confirming the presence /absence of (C)APD using gold standard behavioural diagnostic tests or based on confirmed site of lesion. Behavioural gold standard tests are those that measures different auditory processes described by ASHA (1996, 2005). According to the ASHA task force (2005), no single test or procedure produces acceptable results in terms of sensitivity and specificity. Hence, a test battery approach was recommended to be used to check for the efficiency of screening tests.

ASHA (2005) recommended that the diagnosis of a central auditory processing disorder should be accomplished using a variety of indices, including case history, non-standardized but systematic observation of auditory reference and audiological test procedures. ASHA recommended categories of behavioural auditory measures including tests of temporal processes such as ordering, discrimination, resolution (e.g., gap detection); integration; localization and lateralization; low-redundancy monaural speech (time compressed, filtered, interrupted, competing, etc); dichotic stimuli (including competing nonsense syllables, digits, words, and sentences); and binaural interaction procedures (e.g., masking level difference). Electrophysiological procedures (Middle Latency Response, Long Latency Response, and Event Related Potential) have been considered useful for (C)APD assessment.

The suggestion to use a test battery approach while evaluating those with (C)APD is not new. Willeford (1974, cited in Amos & Humes, 1998) first demonstrated the potential value of administering (C)APD tests on children. The use of a test battery approach for the diagnosis of (C)APD continued to be advocated by Willeford (1977). The author's rationale to use the test battery approach was that different tests assessed the CNS at different levels. Thus, the uses of three major tests were recommended. These included a test of Binaural Fusion task which assessed the brainstem, filtered speech to test the lower centre of the temporal lobe and binaural separation or dichotic listening task (digits, CV, spondee words) to evaluate the function of the temporal lobe and higher levels of the central auditory pathway. A later version of the Willeford battery added synthetic speech identification (SSI), and compressed speech. While the earlier version of the Willeford battery focused on assessing CANS at different levels, the latter version concentrated on the assessment of different processes as listed by ASHA (1996, 2005).

Chermak and Musiek (1992) recommended that a (C)APD diagnostic evaluation should minimally include at least one test of temporal processing, one dichotic test and one monaural low redundancy test. If the child performed poorly in one area, another test was suggested to be administered to evaluate the skill more comprehensively. Chermak and Musiek (1997) observed that two tests that measure similar process, even though highly efficient, should be replaced by less efficient tests that assess different processes.

Barren (2007) reported that it is unusual that an individual with (C)APD would experience a deficit in each of the auditory processing skills. Therefore, the author suggested the selection of a comprehensive and valid test battery. This was felt necessary to ensure that a person with (C)APD does not go undiagnosed. Furthermore, as (C)APD is a heterogeneous group of auditory deficits, it was considered important that a test battery approach be used so that different underlying process, as well as different level of functioning within the CANS, could be assessed.

Various studies in the literature have suggested that the diagnosis of (C)APD could be based on either a combination of behavioural tests, electrophysiological and electro-acoustic tests or using only one of these tests. Hurley and Musiek (1997) compared behavioural tests such as Dichotic Digit Test (DDT) and Auditory Duration Pattern Test (ADPT), with an electrophysiological test (P_{300}) to identify cerebral lesions. The authors found that ADPT was more sensitive in detecting the presence of cerebral lesions, followed by DDT. P_{300} was found to be only moderately sensitive. Chermak (2001) suggested that the diagnosis of the (C)APD should be made based on the outcomes of behaviour tests, supplemented by electro-acoustic measures and, to a lesser extent, by electrophysiological measures. These findings suggest that behavioural tests should be the first choice while choosing a test to diagnose (C)APD.

Though it is an established fact that behavioural tests are superior, many studies have debated regarding which tests have to be used for diagnostic assessment. Keith (1996) reported that there is no consensus about which tests should be included for the test battery approach. Sensitivity and specificity of a test battery has been found to differ depending upon the tests used in the assessment process. However, there is no gold standard presently available for following a test battery approach.

Though researcher disagree regarding the constitution of the test battery, they all agreed that a test battery approach for diagnosis of (C)APD should be used (Musiek & Chermak, 1995; Keith, 1996; ASHA, 1996, 2005). Musiek and Chermak (1995) suggested that the first order diagnostic tests should include dichotic digits, the dichotic sentence test, one of the temporal ordering tests (e.g. frequency pattern test) and the duration pattern test in case of adults. The second order tests that were suggested included MLR, Staggered Spondee Word test (SSW), Tallal's ordering test, the dichotic rhyme test and time compressed speech.

Musiek, Geurkink, Kietel and Hanover (1982) have used seven diagnostic tests. These included the competing sentences (CS), Rapidly Alternating Speech Perception Test (RASP), Binaural fusion (BF), Low Pass Filtered Speech (LFPS), Staggered Spondaic Word test (SSW), Dichotic Digits (DD) and Frequency Pattern Test (FPT). Their results showed that the test which most frequently detected the presence of the disorder was the competing sentence test. The next most sensitive tests were frequency pattern tests, dichotic digits and SSW. On the other hand, equal number of individuals failed LPFS, BF, RASP. The authors also found a significant difference among the subjects who had a different auditory processes affected.

Ferre and Wilber (1986) used a test battery of Low Pass-Filtered Speech (LPFS), Binaural Fusion (BF), Time Compressed Speech (TC) and Dichotic CV (DCV). The authors found that the LPFS test detected (C)APD more frequently, followed by Binaural

Fusion test (BF). Further, Time Compressed test and DCV had equal sensitivity in detecting (C)APD. In addition, it was also found that there was heterogeneity in the performance of the subjects in the various tests. This emphasized the importance of administering the test battery rather than a single test.

Keith (1996) also recommended a behavioral test battery approach for children in the age range of 6 to 12 years. Their test battery included a questionnaire regarding auditory processing disorder and attention deficit disorder, pure-tone and speech measures in quiet, immittance testing, dichotic measures including words and sentences, filtered words, speech-in-noise, temporal processing, auditory vigilance, auditory discrimination, auditory analysis, auditory memory and auditory receptive language.

Schow et al. (2000) observed that while ASHA (1996, 2005) gave various behavioural tests which could be used to assess each auditory process, they did not define how an available test measure corresponds to an identified underlying auditory phenomenon. Schow et al. (2000) undertook a confirmatory factor analysis to elucidate this issue more clearly. They identified tests that would effectively measure four different auditory processes. These included, the Auditory Patterning Temporal Ordering (APTO), which could be assessed by tests such as frequency and duration pattern test. The next process comprised of Monaural Separation / Closure (MSC), which could be assessed using monaural low-redundancy speech tests such as low-pass filtered speech and similar measures. Thirdly, Binaural Separation (BS), which could be measured by dichotic tests involving directed attention were suggested. Finally, Binaural Integration (BI) was recommended to be measured, for which dichotic tests involving nondirective attention were included.

Bellis (2003) also recommended that a comprehensive central auditory test battery be chosen to assess the following such as a dichotic listening task that involves directed attention (BS), a dichotic listening task that involves report of both ears (BI); a temporal patterning such as frequency or duration patterns (APTO); a test of monaural low-redundancy speech, such as Low Pass Filtered Speech (LPFS), compressed speech with or without reverberation, or one of the monaural sentence competing tests; a temporal gap detection test, such as the RGDT (temporal resolution); a binaural interaction test, such as binaural fusion test or MLD; an auditory discrimination task and physiological measures of the auditory function, such as ABR, MLR, and late event-related potential. Bellis (1996) summarized the various (C)APD tests and the process that are tapped (Table R1)

Table R1: *Summary of the tests used assess the each process (Bellis, 1996)*

Auditory Process	**Sub auditory process(es)**	**Test (s) used to assess the auditory process**
Binaural integration	Binaural integration	Dichotic digits (DD) (Kimura, 1996; revised by Musiek, 1983) Dichotic consonant vowel (DCV) (Berlin et al., 1972) Staggered spondee word test (Katz, 1962) Competing sentence test (developed by Willeford, 1968, described by Willeford & Burleigh, 1994) Synthetic sentence identification test with contralateral competing message (Jerger & Jerger, 1974; Jerger & Jerger, 1975) Dichotic sentence identification test (Fifer, Jerger, Berlin, Tobey & Campbell, 1983) Dichotic rhyme test (Wexler & Hawles, 1983)

Temporal processing	Temporal resolution	Random Gap Detection Test (RGDT) (Keith, 2000)
	Frequency discrimination, temporal ordering, linguistic labelling	Frequency pattern test (Pinherio & Ptacek, 1971)
	Duration discrimination, temporal ordering, linguistic labelling	Duration pattern test (Pinherio & Musiek, 1985)
	Temporal discrimination	Psychoacoustic pattern discrimination test (PPDT) (Blaettner et al., 1989)
Auditory figure-ground process	Auditory closure	Low pass filtered speech (LPFS) (Bocca, Calearo & Cassinari, 1954)
	Auditory closure	Time compressed speech with or without reverberation (Wilson, Preece, Salamon, Speery & Bornstein, 1994)
	Auditory figure-ground process/ auditory closure	Synthetic speech identification with ipsilateral competing message (SSI-ICM) (Jerger & Jerger, 1974, 1975) Synthetic speech identification with contralateral competing message (SSI-ICM) (Jerger & Jerger, 1974, 1975)
	Auditory figure-ground process/ auditory closure	Speech-in-noise test (SPIN) (Olsen, Noffsinger & Kurdziel, 1975)
Binaural	Binaural	Rapidly alternating speech perception (RASP)

interaction	interaction	Binaural fusion (Willeford & Bilger, 1978) Masking level differences (Matzker, 1959)
	Binaural interaction/ lateralization	Interaural just-noticeable differences (Pinherio & Tobin, 1969, 1971)

There are several tests to asses (C)APD that have been developed in India. Yathiraj (2008) has listed the tests along with the process assessed (Table R 2).

Table R 2: *Audiological tests used to assess (C)APD developed in India (Yathiraj, 2008)*

Auditory Process	**Sub Process**	**Central Auditory Tests**
Binaural integration	Binaural integration	Dichotic CV revised – Normative Data on children (Krishna & Yathiraj, 2001) Dichotic CV revised – Normative Data on adults (Prachi & Yathiraj, 2002)
Monaural low redundancy tests	Auditory closure	Time compressed speech test in English for children (Sujitha & Yathiraj, 2005) Time compressed speech test in English for adults (Prawin & Yathiraj, 2006)
Temporal processing	Duration discrimination, temporal ordering, linguistic labelling Temporal integration	Duration Pattern Test (Gouri & Manjula, 2003) Gap detection test (ShivaPrakash & Manjula 2003)
	Frequency discrimination, temporal ordering, linguistic labelling	Pitch pattern sequencing test (Shivani & Vanaja, 2003)
Binaural interaction	Binaural interaction	Binaural fusion test in English (Shivaprasad & Yathiraj, 2006)

Auditory memory	Auditory memory	Auditory memory test in English (Yathiraj & Mascarenhas, 2003) Auditory memory test in Kannada (Yathiraj & Vijayalakshmi, 2005)

Yathiraj and Mascarenhas (2003) reported that children who were identified as having (C)APD did not show identical processing deficits. Hence, they recommended profiling each child, using various tests, to help in further management. Bellis (2003) also supported that comprehensive central auditory evaluation would be necessary to confirm and define the disorder, as well as in developing the deficit-specific management program.

From the literature regarding the test battery approach, it is clear that a combination of tests should be used to assess children with (C)APD. However, there is no agreement among the various authors regarding the tests to be used to diagnose (C)APD. However, it has been agreed that tests evaluating different processes should be used to assess most of the auditory processes. Keeping in mind the review of literature, the method of the study was designed.

METHOD

The present study was undertaken to investigate whether the ‘Screening Checklist for Auditory Processing’ (SCAP) could be used as a effective tool to screen children for the presence or absence of (C)APD. The study was carried out in two stages. In the first stage, SCAP was used to detect children who had or did not have symptoms of (C)APD. In the second stage, SCAP results were compared with the results of a (C)APD test battery. The participants for the second stage of the study were randomly selected from those included in the first stage.

Participants

A total of 3120 children in the age range of 8 to 15 years were screened using the SCAP. These children were selected from four different English medium schools and had studied English for at least two years. Among them, 80 children were randomly selected for further diagnostic evaluation, ensuring that they had varying score on the SCAP. Only 42 children could finally be evaluated, since the remaining declined to be evaluated further. The mean age of these 42 children was 10.93 years.

It was ensured that all the children who were suspected to diagnostic evaluation had normal IQ, as determined through Raven’s Progressive coloured/standard Matrices (Raven, 1952). In addition, they had normal hearing. Their pure-tone AC and BC thresholds were less than 15 dB HL for octave frequencies from 250 Hz to 8 kHz and 250 Hz to 4 kHz, respectively. Normal middle ear function was confirmed with the presence of ‘A’ type tympanograms and both ipsilateral and contralateral acoustic reflex being present for the frequencies 500 Hz, 1 kHz and 2 kHz. In addition, all the participants had a speech identification score that was greater than 85% in quiet, which was determined using the ‘Common Speech Discrimination Test for Indians’ (Mayadevi, 1974). Further, the teacher and the caregivers reported that none of these children had any history of a speech and hearing problem.

Material

The material used in the study included the ‘Screening Checklist for Auditory Processing’ (SCAP) developed by Yathiraj and Mascarenhas (2002). It was used to check if the children had or had not symptoms for (C)APD. The checklist comprised of 12 questions on symptoms of deficits in auditory processing (Appendix A). The questions pertained to auditory perceptual processing, auditory memory and other miscellaneous symptoms.

The ‘Common Speech Discrimination Test for Indians’, developed by Maya Devi (1974), was used to check for normal speech identification abilities of the children. The test contained 25 common monosyllabic nonsense CVs that are used across several Indian languages.

The Speech-in-Noise test (SPIN) was administered using the ‘Monosyllabic Speech Identification Test in English’ that was developed by Rout (1996) for English speaking Indian children, along with speech noise. This was used to assess auditory separation / auditory closure ability.

Dichotic CV (Yathiraj, 1999), was used to assess auditory integration. The 0 ms lag list of the test was administered. Gap Detection Test (GDT), using the signal generated by Shivaprakash and Manjula (2003), was utilized to assess temporal processing. As the signals were identical to that developed by Musiek et al. (2005), the norms for children given by Chermak and Lee (2005) were used to compare the gap detection threshold. The norms given by Shivaprakash and Manjula (2003) were not used as they were found to differ considerably from that reported in the literature. As the test was a non-linguistic one, it was considered acceptable to use western norms.

The auditory memory and sequencing abilities was assessed with the 'Auditory Memory and Sequencing Test' (AMST) developed by Yathiraj and Mascarenhas (2003). The norms obtained by Devi, Sujitha and Yathiraj (2006) were used to categorise the children. Only the auditory memory subsection of the test was used.

Equipment

A calibrated dual channel diagnostic audiometer OB 922 (version 2) with AC (TDH-39) and BC (B-71) transducers was used to carryout pure-tone audiometry, speech audiometry and the (C)APD tests. A calibrated immittance meter (GSI Tympstar) was used to ensure the presence of normal middle ear function. The CD version of the test material was played through a Compaq Presario 6000 laptop with Intel Pentium dual core processor. Interacoustics AC-40 clinical audiometer was utilized to administer the Masking Level Difference (MLD) test.

Test Environment

Part of stage I of the study was carried out in a quiet room, free from distraction. This included administrating the screening checklist and IQ testing. All the audiological tests of stage I and stage II were carried out in a two-room situation with permissible noise limits as per ANSI standards (S3.1-1991).

Procedure

Stage I

Procedure for Selection of participants

Screening for the presence of (C)APD was carried out on school-going children from four different schools. 61 teachers who had taught the children for at least one year were asked to identify those with a suspected (C)APD using the SCAP. Each teacher was required to indicate on the copies of the checklist given to them, whether the symptoms were present or absent for each of the children in their class. The checklist was scored on a two point rating scale. Each answer marked 'Yes' was scored '1' and each 'No' was scored '0'.

Eighty children with varying scores on the checklist were randomly selected from four different schools. It was ensured that the score ranged from 0-12. Though, 80 children were selected for further evaluation, only 42 of them reported. Of them, 22 had scores less than 50% (mean age of 11.22 years) and 20 had scores of 50% and above (mean age of 10.65 years).

It was ensured that all the children met the participant selection criteria which included normal peripheral hearing; normal speech identification in quiet; and normal IQ.

Only those participants who met the above criteria were subjected to further (C)APD evaluation in stage II of the study.

Oral consent was taken from the caregivers of the participants before carrying out the second stage of the study. The caregivers of the participants were briefed about the study, its aims, method and duration of testing, prior to obtaining their consent.

Stage II

Procedure for (C)APD evaluation

In stage II, the diagnostic tests were administered. All the participants were evaluated using five different (C)APD tests. The tests included SPIN which evaluated auditory separation; Dichotic CV test to determine auditory integration; Masking Level Difference (MLD) to check auditory interaction; the Gap Detection Test (GDT), to obtain the information on temporal processing abilities; and Auditory Memory and Sequencing Test (AMST) to determine auditory memory skills.

The SPIN, Dichotic CV, GDT and AMST tests were administered using the CD version of the tests which were played on a computer. The output from the computer was routed through an audiometer. The MLD test was administered using signals generated by an audiometer. The outputs of the all tests were presented through the headphones, except AMST which was presented through sound-field speakers.

The Speech-in-Noise (SPIN) test was administered using the recorded version of ‘Monosyllabic speech identification test in English for Indian children’ (Rout, 1996) in the presence of speech noise. The signal was presented monaurally to each ear at 0 dB SNR at 40 dB SL (ref. SRT). Verbal responses of the participants were noted. A correct response was given a score of ‘1’ and an incorrect response a score of ‘0’.

The Dichotic CV test was played using the CD version of the test (Yathiraj, 1999) at 40 dB SL (ref. SRT). The participants were asked to repeat the syllables which were heard through headphones. Their double correct responses were noted and compared with norms given by Krishna (2001).

Masking level difference (MLD) was evaluated using a 500 Hz tone at 50 dB HL. The stimuli were presented binaurally through headphones in both homophasic and antiphasic conditions. The noise level was increased until the participants were unable to hear the signal. MLD was calculated by subtracting the $S_\pi N_o$ (antiphasic) threshold from that of the $S_o N_o$ (homophasic) threshold. The responses were compared with norms provided by Wilson, Zizz, and Sperry (1994).

Gap detection test (GDT) was obtained with the CD version of the test. The signals were presented monaurally to each ear at 40 dB SL (ref. PTA) through head phones. The participants were required to indicate as to which set of noise bursts in a triad contained a gap. The minimum gap duration which the participants were able to detect was compared with norms given by Chermak and Lee (2005).

CD version of Auditory Memory and Sequencing Test (AMST) developed by Yathiraj and Mascarenhas (2003) was presented through a loudspeaker in a sound-field condition at 40 SL (ref. SRT). The loudspeaker was placed at a 45^0 azimuth at a distance of one meter from the head of each participant. The participants were asked to repeat the words heard by them. A score of ‘1’ was given for each correctly repeated word to calculate the auditory memory score. The responses were compared with age appropriate norms developed by Devi, Sujitha and Yathiraj (2006).

The entire test duration for each participant was approximately two hours. Breaks were given between the testing. Suitable reinforcement was given to the participants.

Test-retest reliability

Test-retest reliability was done for responses got in stage I and stage II. To check for the test-retests reliability of SCAP, the questionnaire was re-administered on 606 children (20%) after the gap of three months. This was done by eight teachers who had answered the checklist earlier. Further, in stage II, two of the 42 participants were randomly selected to check for the test-retest reliability of the diagnostic tests after a gap of three months. All five (C)APD tests were re-administered on these two participants. Due to a time constraint, only two children were re-evaluated.

Scoring

All the tests administered were scored according to the norms provided for each of the tests. The participants were considered to have a problem in a specific process, if his/her score on the particular test were below the age appropriate normative data.

Participants were diagnosed as having an auditory processing disorder if they failed in two or more of the of the five (C)APD tests used in the present study. If they failed only one test, they were considered to have (C)APD if the score on that test was at least three standard deviations below the mean performance of the normative score. This diagnosis was done in keeping with the recommendations of Musiek and Chermak (1997).

Analyses

The obtained score were tabulated and analysed as follows:

- Agreement of each question of SCAP with the presence of (C)APD
- Agreement of each question of SCAP with each (C)APD tests
- Correlation of SCAP scores with the (C)APD tests
- Sensitivity and specificity of different SCAP cut-off scores
- Profiling of (C)APD tests finding of the participants with the best cut-off SCAP score
- Prevalence of (C)APD
- Test- retest reliability of SCAP and the (C)APD tests

The details of the statistical analyses used for the study are described in the following chapter. The results obtained are discussed with the references to a review of literature.

Results and Discussion

The aim of the present study was to utilize SCAP to detect children with symptoms of central auditory processing disorder. This was carried out to examine the efficiency of SCAP to screen children for the presence of a (C)APD and to set a cut-off criterion to differentiate children with suspected (C)APD from those without it. In addition, the agreement between the checklist and a battery of the diagnostic tests was also determined.

The results of the study are discussed under the following headings:

A. Presence of (C)APD

   a. Presence of (C)APD symptoms as per SCAP checklist

   b. Presence of (C)APD as per the diagnostic tests

B. Agreement of each question of SCAP with (C)APD

   a. Agreement of each question of SCAP with each of the (C)APD tests

   b. Agreement of each question of SCAP with presence/absence of (C)APD

C. Relation between overall SCAP scores and (C)APD

   a. Correlation between overall SCAP score and each of the (C)APD tests

   b. Agreement between different cut-off scores of SCAP and the results of the diagnostic tests.

   c. Sensitivity and specificity of SCAP using different cut-off scores

D. Prevalence of (C)APD in school-going children

E. Profiling of based on (C)APD test findings

F. Reliability measures of the SCAP checklist and the (C)APD test battery

A. Presence of (C)APD

The data were analysed to detect children with symptoms of (C)APD based on SCAP scores as well as identify those with confirmed (C)APD. The latter was done utilizing a diagnostic test battery.

a. Presence of (C)APD symptoms as per SCAP checklist

The SCAP finding of the 3120 school-going children was analysed to determine the number of children who had symptoms of (C)APD. It was found that 216 (6.9%) of the children had some symptoms of (C)APD as per SCAP.

Table -1 gives the total number of children who had presence of the symptoms of (C)APD. This data is provided for each of the 12 questions of SCAP. Table-1 as well as Figure-1 reveals that the symptoms that occurred most frequently were ‘Requires repeated instruction’ (4.9%) and ‘Short attention span’ (4.2%). The other symptoms that were present fairly frequently were ‘Poor academic performance’ (3.7%) , ‘Forgets what is said in a few minutes’(3.6%) , ‘Easily distracted by background noise’ (3.4%) and ‘Delayed response to verbal instruction or questions’ (3.1%).

Table 1: *Number of children who had positives responses for each of the questions of SCAP.*

No.	**Questions**	**Number of positive response**
1.	Does not listen carefully and does not pay attention (requires repetition of instruction)	153 (4.9%)
2.	Has a short attention span of listening (approx. 5-15 mins)	133 (4.2%)
3.	Easily distracted by background sound	107 (3.4%)
4.	Has trouble in recalling what has been heard in the correct order	86 (2.8%)
5.	Forgets what is said in few minutes	114 (3.6%)
6.	Has difficulty in differentiating one speech sound from other similar sound	31 (0.99%)
7.	Has difficulty in understanding verbal instruction and tend to misunderstand what is said which other children of the same age would understand	63 (2%)
8.	Show delayed response to verbal instruction or questions	98 (3.1%)
9.	Has difficulty in relating what is heard with what is seen	41 (1.3%)
10.	Poor performance in listening task, but performance improves with visual cues	74 (2.4%)
11.	Has pronunciation problem (mispronunciation of words)	51 (1.63%)
12.	Performance is below average in one or more subjects, such as social subjects, I/II language	115 (3.7%)

Note: Numbers of children screened were 3120 in the age range between 8 to15 years.

The symptoms that occurred the least (0.99%) was questions of which dealt with discrimination of phonemes. It is possible that the teacher did not understand the questions rather than the symptom really not being present. It is suggested that the question should be accompanied with an example, to make the questions clearer.

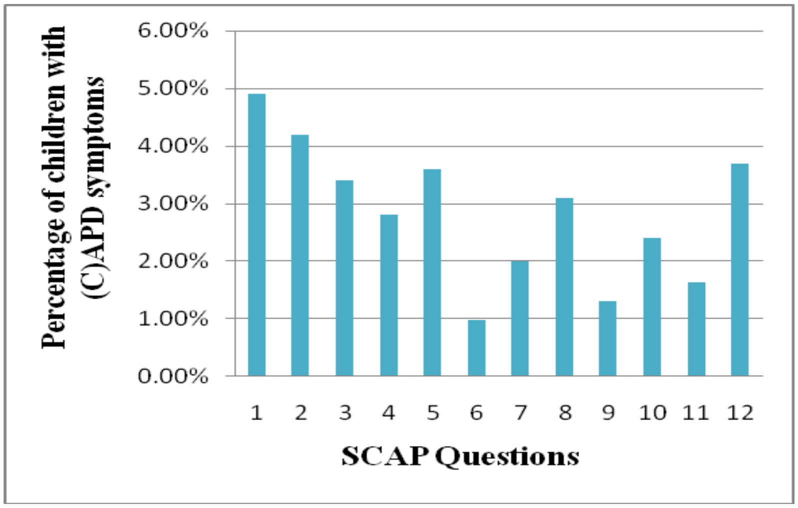

Figure 1: Percentage of children who had positive responses on each question of SCAP

Symptoms which occurred more frequently could probably act as greater indicators of (C)APD. In the present study, it was found that the occurrence of attention and memory related symptoms were more followed by poor academics. Similar findings were obtained by Smoski, Brunt and Tannahill (1992). They too observed, based on the findings of CHAPPS, that ‘affected memory’ was a common symptoms seen in children with (C)APD. However, a more common symptom noticed by them was ‘difficulty in hearing in the presence of noise’. This was also a common symptom seen in the present study as well as by Musiek and Guerkink (1980).

In contrast, Sanger, Freed and Decker (1985) reported that the symptoms that was least seen in their group of children with suspected auditory processing disorder was ‘auditory memory’. They noticed this finding using a 23-item informal checklist.

The variation seen across the studies including the present studies could be due to the heterogeneity seen in children with suspected (C)APD. Yet another reason for the variation in the finding may have due to an observer bias. Different teacher probably were more observant of certain symptoms compared to other symptoms, thus resulting in the variations seen across the studies.

b. Presence of (C)APD as per the diagnostic tests

The finding of the diagnostic tests carried out on the 42 participants were tabulated. Table 2 and Figure 2 provide information regarding the number of children who failed each of the diagnostic tests. In addition, the number of children who were label to have (C)APD as per the recommendation of Chermak and Musiek (1997) is also given.

Table 2*: Number (%) of participants who failed each (C)APD diagnostic test and were diagnosed to have (C)APD.*

SPIN		**GDT**		**MLD**	**DCV**	**AMT**	**Presence of (C)APD**
Rt ear	**Lt ear**	**Rt ear**	**Lt ear**				
8 (19%)	6 (14%)	7 (16.6%)	6 (14.2%)	1 (2.3%)	16 (38%)	14 (35%)	17 (40.4%)

Note: The total number of participant was 42 except for the auditory memory test, where it was 40.

Among the diagnostic tests, the tests with maximum failure was DCV (38%) followed by AMT (35%), SPIN (average of 16.5%) and GDT (average of 15.5%). Only one participant failed the MLD test. Using the criteria suggested by Chermak and Musiek (1997), 40.4 % (17) of the participants were diagnosed to have (C)APD.

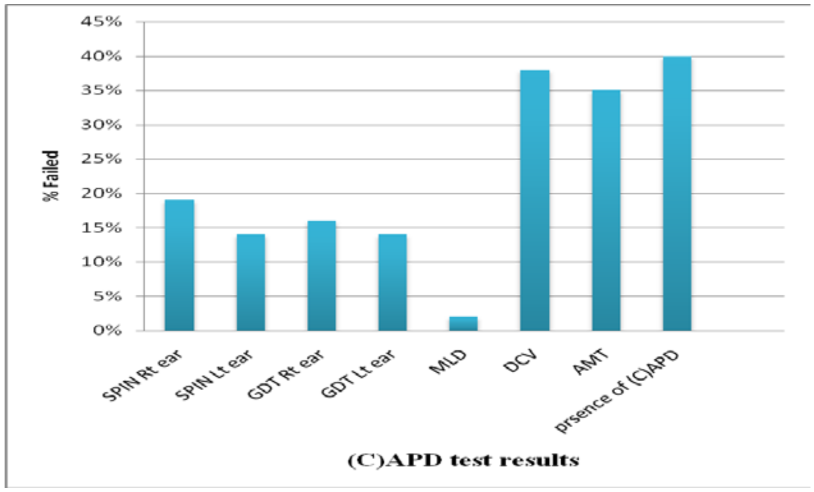

Figure 2: Percentage of children who failed each diagnostic test and were diagnosed to have (C)APD

From the finding it can be construed that children with (C)APD have varied performance on the (C)APD diagnostic tests, with a greater number of them have difficulty in auditory integration and auditory memory. Further, on the SPIN and GDT, a larger number of participants failed when tested in the right ear, when compared to left ear.

The finding of Musiek, Geurkink, Kietel and Hannover (1982) are in consensus with that of the present study. They too noted that their children with (C)APD failed most often on different diagnostic tests, including the presence of an auditory integration problem. However, they too reported of a larger number of their participants having temporal processing problems, as assessed by the frequency pattern test.

To find out the agreement between the SCAP results and (C)APD findings, further analysis was done. The agreement was checked between each question of SCAP and the diagnostic tests, as well as between each questions with the overall diagnosis of (C)APD.

B. Agreement of each question of SCAP with (C)APD

Initially, the agreement of the each of the questions of SCAP with each of the five diagnostic tests, SPIN, GDT, MLD, DCV, AMT was determined. In addition, the agreement of the each of the twelve questions with the presence or absence of the (C)APD was also checked.

a. Agreement of each question of SCAP with each of the (C)APD tests

To check whether there was an agreement between each question and a particular diagnostic test (SPIN, GDT, MLD, DCV, AMT), the Kappa measure of agreement was done. Chi-square could not be utilized since the expected frequency count of five was not obtained in all quadrants of the 2 x 2 table.

For the question 'Forgets what is said in few minutes', the Kappa test showed a significant agreement with the SPIN score obtained for the both the right [k (1) = 0.32, ($p < 0.05$)] and the left ear [$k = 0.30$, ($p < 0.05$)]. Likewise, there was a significant agreement ($p < 0.05$) found between the seventh, eighth, ninth and tenth questions (Table1 provides details of the questions) with the SPIN results of both the ears. However, the agreement between these questions and SPIN results was only moderate. There was no agreement observed for other questions with any of the (C)APD tests.

b. Agreement between each question of SCAP and presence of (C)APD

The agreement between the responses of each questions of SCAP with the presence of or absence of (C)APD was checked using Kappa measure of agreement. Table 3 shows the number of times (C)APD was present or absent for each of the 12 symptoms listed in SCAP.

It is evident from the Table 3 probability of occurrence of (C)APD with respect to each questions was less than chance level (< 50%). Hence, it can be inferred that a single question of SCAP cannot serve as an indication of the presence / absence of (C)APD.

In addition, the agreement between the each question of SCAP and the presence / absence of (C)APD was found out using the Kappa measures of agreement. The results of the Kappa revealed that there was no statistically significant ($p > .05$) agreement between any question of SCAP and presence / absence of (C)APD.

The above findings substantiates that only one question of SCAP cannot be used to suspect the presence / absence of (C)APD and make a judgment as to whether a client is to be referred or not. As the agreement between the each SCAP questions and presence and absence of (C)APD was poor, it would probably be better if groups of question be used to suspect the presence / absence of (C)APD, instead of individual questions.

Table 3*: Presence /absence of (C)APD for each SCAP symptom*

Q. No	SCAP response	Presence of (C)APD	Absence of (C)APD	Q. No	SCAP Response	Presence of (C)APD	Absence of (C)APD
1.	Yes	2 (25%)	6 (75%)	**7.**	Yes	9 (31%)	20 (69%)
	No	15 (44%)	19 (56%)		No	8 (61%)	5 (39%)
2.	Yes	5 (35%)	9 (65%)	**8.**	Yes	4 (27%)	11 (73%)
	No	12 (42%)	16 (58%)		No	13 (48%)	14 (52%)
3.	Yes	6 (33%)	12 (67%)	**9.**	Yes	14 (38%)	23 (62%)
	No	11 (46%)	13 (54%)		No	3 (60%)	2 (40%)
4.	Yes	5 (31%)	11 (69%)	**10.**	Yes	11 (38%)	18 (62%)
	No	12 (46%)	14 (54%)		No	6 (46%)	7 (54%)
5.	Yes	4 (17%)	10 (83%)	**11.**	Yes	14 (37%)	24 (63%)
	No	13 (46%)	15 (54%)		No	3 (75%)	1 (25%)
6.	Yes	15 (37%)	25 (63%)	**12.**	Yes	3 (27%)	8 (73%)
	No	2 100%	0		No	14 (45%	17 (55%)

None of the checklist for (C)APD, reported in the literature, have recommended A referral based on only one symptoms of (C)APD. Smoski, Brunt and Tannahill (1992) also reported that the symptoms of (C)APD vary from child to child as well as situation to situation. Due to this heterogeneity, they recommend that it would be better to use groups of questions to refer a child for further diagnostic assessment. Thus, the findings of present study are in consensus with the recommendation of studies published in the literature. These studies also suggest the use of multiple questions when deciding whether to refer or not clients for detailed evaluations.

As the agreement between individual questions and the diagnostic findings was poor, an attempt was made to compare the total score of SCAP with the diagnostic test results. This is described in the next section.

C. Relation between overall SCAP score and (C)APD

The results were analyzed to determine the following

a. Correlation between overall SCAP scores and each (C)APD diagnostic test
b. Agreement between cut-off scores of SCAP and the results of the diagnostic tests
c. Sensitivity and specificity of SCAP using different cut-off scores.

a. Correlation between overall SCAP scores and each (C)APD diagnostic test

The overall scores obtained from the SCAP checklist were correlated with results of the (C)APD test battery (SPIN, GDT, MLD, DCV, AMT) using Pearson moment product correlation. The correlation was obtained for the SCAP scores from the 42 participants.

Table 4: *Correlation between SCAP scores and each of the (C)APD tests.*

(C)APD tests	Ear	r
SPIN	Right ear	-0.439*
	Left ear	-0.536*
GDT	Right ear	0.108
	Left ear	0.030
MLD	Both ears	-0.021
DCV	Both ears	-0.286
AMT	Both ears	-0.464*

* Significant at $p < 0.05$ level

It is apparent from Table 4 that there was a significant negative correlation between the SCAP scores and the SPIN scores for the right ear ($r = -0.439$, $p < 0.05$), SPIN scores for the left ear ($r = -0.536$, $p < 0.05$), and the auditory memory test ($r = -0.464$, $p < 0.05$). This indicates that as the SCAP score increased the score of these diagnostic tests decreased. However, this correlation was only moderate ranging from -0.44 to -0.54. There was no correlation between the SCAP scores and any of the other tests of (C)APD.

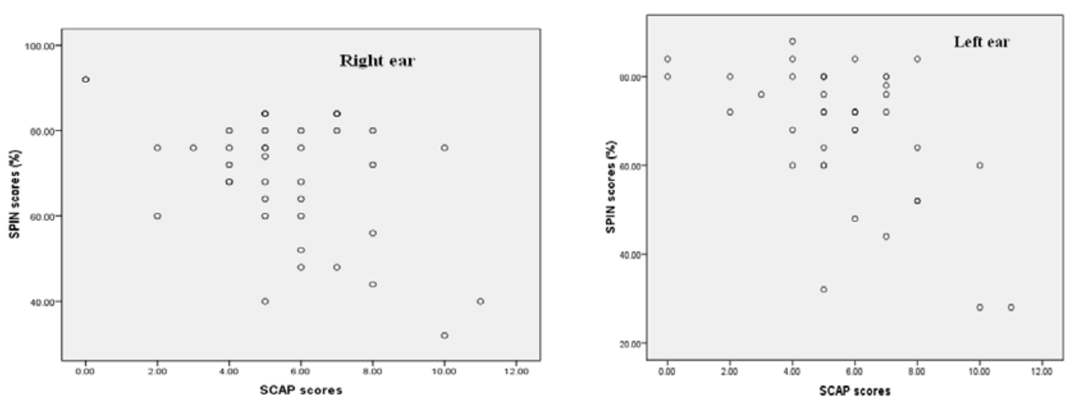

Figure 3: Scatter plot of SCAP scores and SPIN scores for right ear and left ear (N = 42)

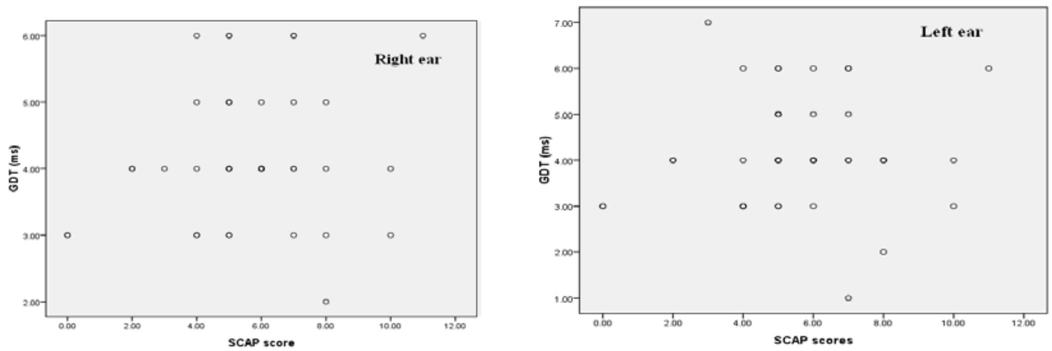

Figure 4: Scatter plot of SCAP scores and GDT scores for the right and left ear (N = 42)

Note: Less number of data points appear, because many participant got the same score

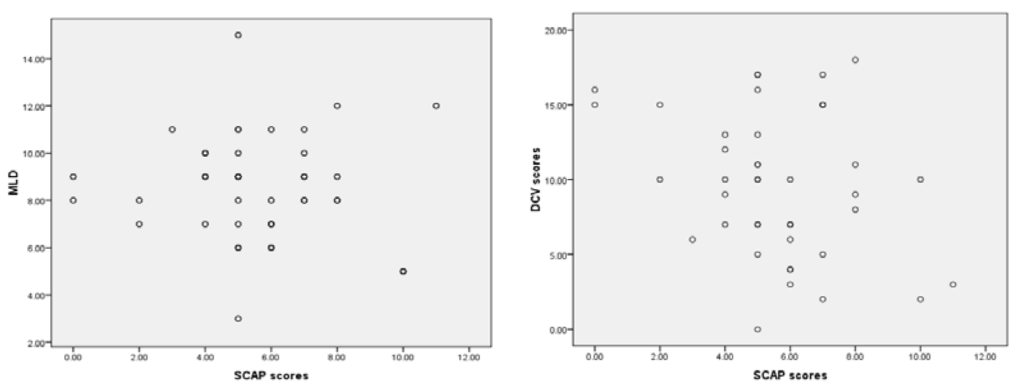

Figure 5: Scatter plot of SCAP score and MLD, DCV scores (N = 42). *Note:*Less number of data points appear, because most of participant got the same score

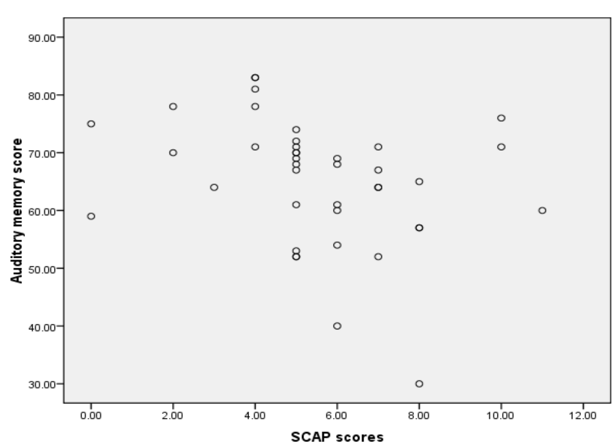

Figure 6: Scatter plot of the SCAP scores and auditory memory recall score (N = 42)

Figure 3 to 6 depict the scatter plots of the SCAP scores and the scores for each diagnostic test, for the 42 participants. It can be seen from the scatter plot that the individual data points were clustered and showed less variation for the SPIN scores (Figure 3). This was also observed for the auditory memory test (Figure 6). Both these tests (SPIN and AMT) correlated significantly with the SCAP scores. On the other hand, the scores for GDT, MLD and DCV in relation to the SCAP scores were more scattered (Figures 4 & 5). This shows the variation in the responses, thus resulting in no significant correlation between the SCAP scores and these test results.

The findings of the present study are unlike that reported by Purdy and Johnstone (2000). They correlated the subsection of CHAPPS with the Dichotic Digit Test (DDT) and the Frequency Pattern Test (FPT). They found scores obtained from Dichotic Digit Tests correlated significantly with the CHAPPS memory rating but not for the other subsection (attention span, listening in noise etc.). However, the authors did not find a correlation between the frequency pattern tests and CHAPPS.

The variation in finding between the present study and that of Purdy and Johnstone (2000) could be due to the differences in the design of the checklists. The CHAPPS uses a lot more questions and a more complex way of scoring when compared to the SCAP. The subtle differences between the questions and rating used in the CHAPPS could have affected the scores obtained on their checklist. This in turn could have affected the correlation between the checklist and the diagnostic tests used by Purdy and Johnstone (2000). Another reason for the differences in findings across the studies could be due to the heterogenic nature of (C)APD. The variation in the participants could have resulted in the difference in correlation between the checklist and the diagnostic tests in the study by Purdy and Johnstone (2000) and in the present study.

b. Agreement between various cut-off scores of SCAP and the diagnostic tests.

The children with varying SCAP scores had been selected for the study. Table5 gives information regarding the number of children who got various scores.

Table 5: *SCAP score obtained by the children*

SCAP score	No of children
0	2
2	2
3	1
4	5
5	12
6	7
7	6
8	4
10	2
11	1

It is apparent from Table 5 that the majority of the participants had scores ranging from 4 to 7, with considerably fewer getting scores below and above these values. It is also evident that from the table that none of the children obtained scores of 1, 9 and 12

The agreement between various cut-off scores of SCAP and the diagnosis of the presence of (C)APD was also ascertained using Kappa measure of agreement. The number of the participant at each cut-off included those with the particular cut-off score as wells those having scores above that particular value. This agreement was done to find which score of SCAP could serve as the best cut-off criteria to indicate the presence / absence of (C)APD.

Table 6: *Agreement for each of the different SCAP cut-off scores with absence/absence of (C)APD.*

SCAP score (N=42)	**Kappa measure of agreement**
2	0.066
3	0.134
4	0.085
5	**0.264***
6	**0.374***
7	0.178
8	0.173
10	0.089
11	0.069

* Significant at $p < 0.05$ level

The results are depicted in Table 6 which revealed that there was a significant moderate agreement for a SCAP cut-off score of five [k = 0.26 ($p < 0.05$)] and six [(k = 0.37 ($p < 0.05$)] with the presence/absence of (C)APD. The agreement was slightly greater for the cut-off scores of six. The other cut-off scores demonstrated no such agreement.

This finding indicates that the score of six was the best cut-off score to define a pass / refer criteria. Probably when the SCAP cut-off score were set lower than six, the over referral rate was high. On the other hand, with a higher SCAP cut-off score the under referral rate was high.

Table 7: *Agreement between the SCAP and (C)APD tests for cut-off scores of 5 and 6.*

(C)APD tests	**Ear**	**SCAP cut-off score 5 Pass (N=10) Referred (N=35)**	**SCAP cut-off score 6 Pass (N=22) Referred (N=20)**
SPIN	Right ear	0.137	0.313*
	Left ear	0.118	0.262*
GDT	Right ear	0.049	0.033
	Left ear	0.030	0.014
MLD	Both ear	0.031	0.005
DCV	Both ear	0.177	0.279
AMT	Both ear	0.191	0.326*

* Significant at $p < 0.05$ level

Additionally, the agreements between the SCAP findings and each of the (C)APD test results were also carried out using the Kappa measures of agreement. This was done with the SCAP cut-off score set at 5 as well as 6 (Table7). These two cut-off scores are selected since they had a significant agreement with the presence/absence of (C)APD.

The results revealed that there was a moderate, yet significant agreement with the SPIN findings for the both ear as well as AMT for the cut-off score of six. However, for the cut-off score of five, there was no such agreement found with any of the (C)APD tests.

Further, the sensitivity and specificity of the SCAP was determined for different cut-off criteria. This was done to confirm the most appropriate cut-off score.

c. Sensitivity and specificity of SCAP using different cut-off scores

The sensitivity and specificity for each cut-off score of SCAP was calculated and tabulated. The number of the true positive (number of participants identified as having (C)APD by SCAP) and number of true negatives (number of participants identified as not having (C)APD by SCAP) were calculated. This was obtained for different cut-off scores of SCAP. Using this information, the sensitivity and specificity was calculated using the following formula:

$$\text{Sensitivity} = \frac{\text{Number of participants identified as having (C)APD by SCAP}}{\text{Total of number of participants having (C)APD}} \times 100$$

$$\text{Specificity} = \frac{\text{Number of participants identified as not having (C)APD by SCAP}}{\text{Total of number of participants not having (C)APD}} \times 100$$

A 2 x 2 decision matrix is depicted in Table 8, giving information about the true positives and true negatives. While Figure 8(a) gives information for a SCAP cut-off score of five, Figure 8 (b) gives information for a cut-off score of six. As mentioned earlier, the cut-off scores of 5 and 6 were selected since they showed a significant agreement with the diagnostic test results.

Table 8: *Decision matrix for SCAP cut-off score of five*

(a)

SCAP cut-off score five	**Diagnostic (C)APD tests results**		**Total**
	Present	**Absent**	
Refer	16 (94%)	16 (64%)	32

Pass	1(6%)	9 (36%)	10
Total	17	25	42

Table 8: *Decision matrix for SCAP cut-off score of* six

(b)

SCAP cut-off score five	**Diagnostic (C)APD tests results**		**Total**
	Present	**Absent**	
Refer	12 (71%)	8 (32%)	20
Pass	5 (29%)	17 (68%)	22
Total	17	25	42

Table 9: *Number of participants who passed / referred for different cut-off score and sensitivity and specificity for various SCAP cut-off scores*

SCAP cut-off scores	**Pass**	**Refer**	**Sensitivity (%)**	**Specificity (%)**
2	2	40	100	8
3	4	38	100	16
4	5	37	94	16
5	10	32	94	36
6	**22**	**20**	**71**	**68**
7	29	13	41	76
8	36	6	23	92
10	39	3	11	96
11	41	1	6	100

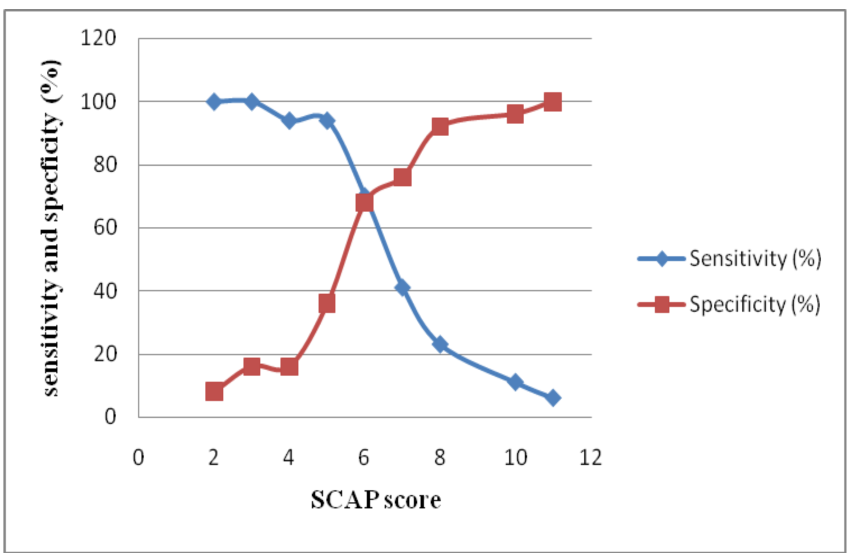

Figure 7: Sensitivity and Specificity for various SCAP cut-off scores.

It is evident from Table 9 and Figure 7 that as the cut-off score of SCAP increased, the sensitivity decreased and specificity increased. With the cut-off score of six, the sensitivity and specificity values were comparable, and with other cut-off scores either the sensitivity was lower or the specificity was lower.

Based on the above finding of the study and the results of the Kappa measures of agreement, the cut-off score of six for the SCAP is recommended to decide whether a child is suspected to have or not have (C)APD. At this cut-off the sensitivity was good without compromising on the specificity.

Little information is provided in the literature regarding the sensitivity and specificity of published screening checklists. Drakes et al. (2006) found that the checklist had a sensitivity of 75% but a specificity of just 25%. Further, the authors reported that CHAPPS under-referred 5 children and over-referred 15 children among the 40 children they evaluated. They observed this finding when using a more stringent diagnostic criterion. To be label the child as having (C)APD, the child was required to fail in two tests at least in one ear for the same process. However, the authors reported that the findings could have been different if they used a lax criterion, as recommended by Bellis (2003).

Cameron, Dillon and Newalli (2005) also noted that CHAPPS results lead to over-referral. They concluded that though CHAPPS scores did not shed light on magnitude of deficits demonstrated in the diagnostic tests. However, it provided information in assessing overall auditory function. It can thus be seen that though the SCAP had a sensitivity that is comparable to that of CHAPPS, its specificity was far higher. While the specificity of CHAPPS was just 25%, that of SCAP was 68% indicating that the latter checklist was more efficient.

The screening tests reported in the literature have sensitivities and specificities that differ from that of present study. Domiz and Schow (2000) found the SCAN developed by Keith (1986) to have a sensitivity of only 45% and a specificity of 95%. Thus, this test has considerably poorer sensitivity compare to the SCAP but a much higher specificity. Using the SCAP would result in a lesser chance of under referral, when compared to the SCAN. On the other hand, MAPA developed by Domitz and Schow (2000) has been found to have a high sensitivity and specificity (83% and 85%) respectively. Though this screening tests would be more efficient in referring / passing children with suspected (C)APD, it would be far more time consuming when compared to SCAP. Schow et al. (2007) reported that the MAPA took around 21 minutes to administer on a child. In contrast, teachers took approximately 10 minutes to answer the SCAP and provide information about the entire class having a strength of 40 to 50.

Thus, it can be inferred that the SCAP is a practical, yet fairly efficient method to screen school-going child to detect (C)APD. Though, it is not as efficient as some other screening tests, it is far more time and cost effective.

D. Prevalence of (C)APD in school-going children

From the SCAP scores obtained from the 3120 children, it was found that 216 (6.9%) of them had one or more symptoms of the (C)APD. However, using the cut-off score of 6, only 83 (2.6%) children were suspected to have (C)APD. On the other hand, the remaining 133 (4.2%) of them had some symptoms of (C)APD but they passed the screening as per this cut-off score. Thus, based on the SCAP results, it can be construed that the possible prevalence of (C)APD, in the population studied was just 2.6% without accounting for the false negatives and false positives (Figure 8).

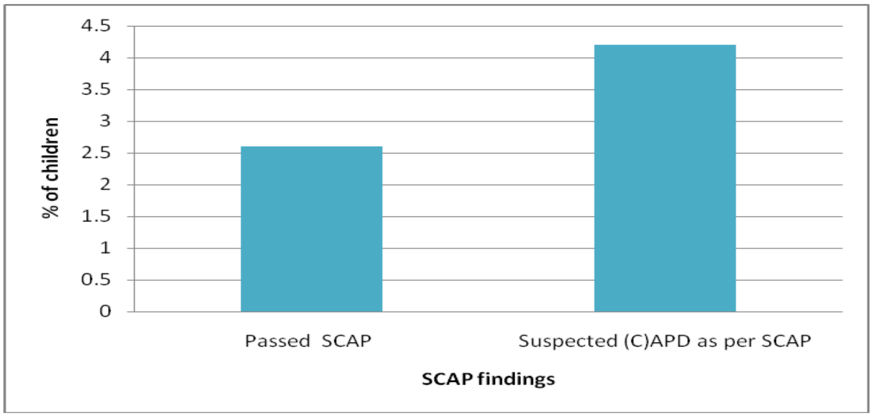

Figure 8: Percentage of children passed /suspected to have (C)APD as per SCAP cut-off of six score

However, the SCAP was noted to have a false negative of 29% [Table 8 (b)]. After correcting for the false negatives by subtracting this group, the number of true positive who failed SCAP was 59 (1.9%). Further, form the Table 8 (b), it is evident SCAP had a false positives of 32% wherein 43 (1.3%) of the children would have been missed. Thus, by adding this group, it can be inferred that the number of children with (C)APD would have been 102 (59 + 43), resulting in a 3.2% truly having a suspected (C)APD.

This prevalence is in agreement with the findings of Chermak and Musiek (1997). They too observed that 2% to 5% of school-aged children have (C)APD, which is not very different form the average 3.2% found in the present study.

E. Profiling of (C)APD Tests

The findings of the 42 children on the five diagnostic tests were categorized depending on their SCAP scores, using a cut-off score of six. Twenty participants obtained scores of six and greater on the SCAP, while 22 obtained scores of below 6.

Table-10: *Percentage of participants who passed / failed the SCAP and failed the diagnostic tests.*

SCAP	**SPIN (Rt ear)**	**SPIN (Lt ear)**	**GDT (Rt ear)**	**GDT (Lt ear)**	**MLD**	**DCV**	**AMT**	**Presence of (C)APD**
Referred (N=20)	35% (N=7)	25% (N=5)	15% (N=3)	15% (N=3)	5% (N=1)	50% (N=10)	55.5% (N=10)	65% (N=13)
Passed (N=22)	4.5% (N=1)	4.5% (N=1)	14% (N=3)	9% (N=2)	0 (N=0)	27% (N=6)	20% (N=4)	22% (N=5)

Table 10 and Figure 9 depict the diagnostic test findings of the 22 participants who were referred and 20 participants who were not referred using the cut-off criteria of six on the SCAP.   The results of each of the diagnostic tests as well as overall diagnosis of the (C)APD are provided.

As evident from the Table 10 and Figure 9, the diagnostic tests that demarked the two groups (pass , refer) were SPIN, AMT and DCV. However, equal number of participant failed in Out of the 20 participants who were suspected to have (C)APD and were referred based on the SCAP results, 13 (65%) had (C)APD. On the other hand, seven (22%) of the 22 participants, who passed the SCAP checklist, were diagnosed to have (C)APD.

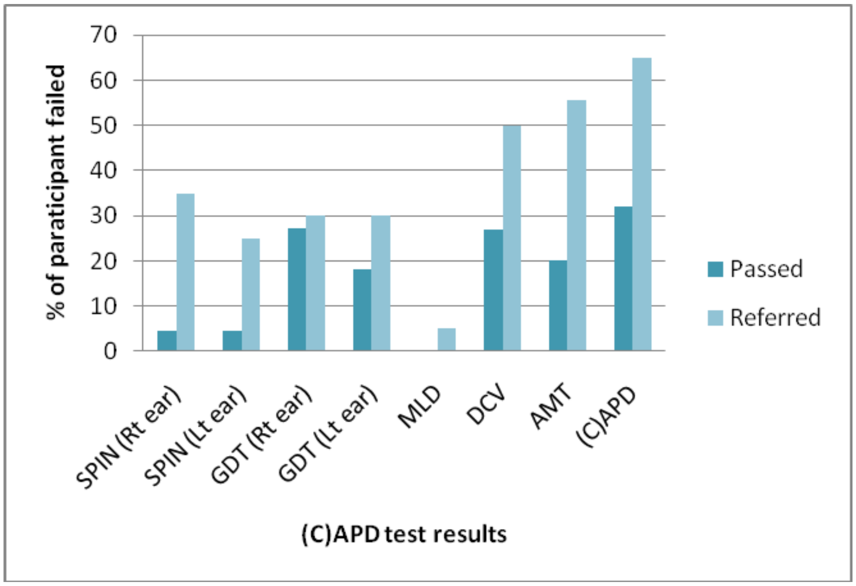

Figure 9: Percentage of participants who passed / failed the SCAP as well as failed the diagnostic tests.

In general, most of the participants failed the DCV and AMT tests, followed by SPIN and GDT. However, only one participant failed the MLD test. Thus, while administering the (C)APD tests, it is necessary to include DCV, AMT, SPIN, and GDT. Higher preference should be given to DCV and AMT during the assessment of (C)APD, as more number of children failed these tests. It can be deduced from the findings of the study that children generally have greater problems with auditory integration and auditory memory, followed by auditory separation / closure and temporal processing.

Further, it was observed that different children failed on different tests indicating that all the children did not exhibit the same kind of auditory processing difficulties. Therefore, it is important to include a battery of tests which assesses different auditory processes. It is recommended to profile each client to pinpoint the exact deficit which in turn would help in better management.

The above finding of the present study is difficult to be compared with that reported in literature. The tests / process that have been assessed in different studies vary. Though there exists variance across studies, a few similarities in choice of tests / process can be observed. Musiek, Geurkink, Kietel and Hanover (1982) also observed that their participants had more difficulty in auditory integration and temporal processing similar to what was found in the present study. However Musiek et al. (1982) rated temporal processing to be the second highest deficits unlike the present study where it was found to be considerably less prevalent. Likewise, the order of processes that were deficient in the present study differs from that reported by Ferry and Wilber (1986). However, they too noted that auditory closure and integration problems were present in their participants. Variation across the studies could be attributed to the variations in the tests administered. Though these studies tap similar process, the actual tests used varied. However, the heterogeneity of the condition could have also contributed to the differences observed across the studies.

In addition to the measures of sensitivity and specificity, reliability of a checklist should be taken into account to decide its efficiency. Therefore, the reliability of SCAP and (C)APD test battery was also evaluated.

F. Reliability Measures

The test-retest reliability was done separately for the checklist as well as for the diagnostic tests. While the reliability of SCAP was tested approximately on 20% of the participants, the reliability of the diagnostic tests was done on approximately 5% of the participants.

a. Reliability of the SCAP

The SCAP was administered on 606 of the total 3120 children who were initially screened using the checklist. This was done by the same eight teachers after a three month interval. During this period, none of the client selected underwent any remedial help. The alpha reliability coefficient was greater than 0.6 [a = 0.77, ($p < 0.05$)] indicating that the test-retest reliability of SCAP was good.

b. Reliability of the (C)APD Test Battery

The test-retest reliability of (C)APD was done on two of the 42 children, who were randomly selected after three months. It was ensured that these two children had not undergone any intervention to improve their auditory perception skills. All the (C)APD tests were re-administered. The results showed that the overall diagnosis of the presence / absence of (C)AP D and the results of each of the tests of (C)APD remained same. Though, there were some differences in the raw scores obtained, the diagnosis continued to be the same.

The overall finding of the present study can be summarized as follows:

- A single symptoms of the SCAP checklist was not a good indicator of the presence of (C)APD. Hence, the need to use a group of symptoms was felt necessary.
- It was found that attention related symptoms were more prevalent in school-going children with suspected (C)APD. This was followed by memory problems and difficulty in hearing in noisy situations.
- A SCAP cut-off score of six yielded a good correlation with the results of SPIN and AMT as well as with the overall diagnosis of (C)APD.
- The cut-off score of six on SCAP resulted in a fairly high sensitivity without compromising on the specificity.
- A sensitivity of 71% and specificity of 68% was obtained for the SCAP when a cut-off criterion of six was used.
- The sensitivity and specificity of the SCAP was comparable with other checklist / tests reported in the literature (Domitz & Schow, 2000; Drakes et al., 2006; Schow et al., 2007).
- Using a cut-off criteria of six on the SCAP, the prevalence of suspected (C)APD in school-going children was 3.2%, after making corrections for the false positives and false negatives.
- SCAP showed a good test-retest reliability.

- The results revealed that the SCAP could be used as a simple and practical measure to screen for the presence of (C)APD.
- Among the diagnostic tests used, most of the participant failed in the AMT and DCV tests, followed by SPIN and GDT. Hence, it is important to include theses test in a diagnostic test battery. It is more essential to include the first two tests as the participants failed them more frequently.
- All the participant who had (C)APD did not demonstrate similar auditory processing difficulties. Thus, a test battery approach should be employed while assessing children for (C)APD.

SUMMARY AND CONCLUSION

Musiek and Chermak (1997) reported that 2 % to 5% of school-going children have (C)APD. Since the prevalence of central auditory processing is high in school-going children, there is a need for an efficient tool to screen and to refer them for further evaluation. There are many screening checklists / tests that have been developed in the past. However, their validity and reliability has not been documented or their sensitivity / specificity are not adequate.

The present study was undertaken to check the utility of the 'Screening Checklist for Auditory Processing' (SCAP) developed by Yathiraj and Mascarenhas (2002) in identifying children with symptoms of (C)APD. The study also aimed at finding the agreement of the SCAP scores with a battery of (C)APD tests. To determine an appropriate cut-off score for SCAP, the sensitivity and specificity of the checklist was aimed to be studied.

With these aims, a total of 3120 children were screened using the SCAP. Forty-two of them, who had varying score on the SCAP, were evaluated using a test-battery consisting of 5 different tests (SPIN, GDT, MLD, DCV, and AMT). These tests were selected to evaluate auditory separation / closure, temporal processing, auditory interaction, auditory integration and auditory memory. The Kappa measure of agreement was used to find the agreement between the SCAP findings and the diagnostic results. Further, the sensitivity and specificity of SCAP was calculated using different cut-off score.

The analysis of the data revealed that:

- A single symptoms of the SCAP checklist was not a good indicator of the presence of (C)APD. Hence, the need to use a group of symptoms was felt necessary.
- It was found that attention related symptoms were more prevalent in school-going children with suspected (C)APD. This was followed by memory problems and difficulty in hearing in noisy situations.
- A SCAP cut-off score of six yielded a good correlation with the results of SPIN and AMT as well as with the overall diagnosis of (C)APD.
- The cut-off score of six on SCAP resulted in a fairly high sensitivity without compromising on the specificity.
- A sensitivity of 71% and specificity of 68% was obtained for the SCAP when a cut-off criterion of six was used.
- The sensitivity and specificity of the SCAP was comparable with other checklist / tests reported in the literature (Domitz & Schow, 2000; Drakes et al., 2006; Schow et al., 2007).
- Using a cut-off criteria of six on the SCAP, the prevalence of suspected (C)APD in school-going children was 3.2%, after making corrections for the false positives and false negatives.
- SCAP showed a good test-retest reliability.

- The results revealed that the SCAP could be used as a simple and practical measure to screen for the presence of (C)APD.

- Among the diagnostic tests used, most of the participant failed in the AMT and DCV tests, followed by SPIN and GDT. Hence, it is important to include theses test in a diagnostic test battery. It is more essential to include the first two tests as the participants failed them more frequently.

- All the participant who had (C)APD did not demonstrate similar auditory processing difficulties. Thus, a test battery approach should be employed while assessing children for (C)APD.

Clinical implication

The present study has following implications:

- The screening checklist can be used to screen children 'at-risk' for (C)APD and refer them for further detailed assessment and rehabilitation.

- The more frequently occurring symptoms on the SCAP could serve as a indicators of the presence of (C)APD.

- The findings of the study give an indication of the choice of tests that should be included in diagnostic test battery.

- The results of the present study highlight that more weightage should be given for DCV and AMT followed by SPIN and GDT while assessing children with (C)APD.

- The diagnostic test results can be used to classify children with (C)APD based on the process that is affected . This can aid in further management.
- The prevalence data gives an idea about the magnitude of the problem in school-going children in India. This information would be useful in planning and carrying out activities related to identification and management of (C)APD in school-going children.

Future direction

- The SCAP and the diagnostic test battery can be administered on individuals from different linguistic background to check their utility across the country.
- Since GDT could not differentiate the children who passed / referred as per SCAP, a study could be carried out to see if any other temporal processing tests would be efficient to tap temporal processing.

References

American Speech-Language-Hearing Association (1996). Central auditory processing: Current status and implication for clinical practice. *American Journal of Audiology, 5,* 41-54.

American Speech-Language-Hearing Association (2005). *(Central) auditory processing disorder (technical report)* Available at http://www.asha.org/members/desref-journals/deskref/default

Amos, N. E., & Hume, L. E. (1998). SCAN test-retest reliability for first-and third-grade children. *Journal of Speech and Hearing Research. 41 (4),* 834-846.

Anderson, K. L., & Smaldino, J. (2000). *Children's Home Inventory for Learning Difficulties (CHILD*). Safa, Switzerland: Phonak hearing system, http://www.phonak.com.

Bellis, T. J. (1996). *Assessment and management of central auditory processing disorder in the educational setting: From science to practice.* San Diego: Singular Publishing Group.

Bellis, T. J. (2003). *Central auditory processing in the educational setting: From science to practice* (2nd Ed.). Clifton Park, NY: Thomas–Delmar Learning.

Central auditory processing disorders (CAPD) checklist. (n.d.). The Speech, Hearing and Learning Center, Inc., Greenville, South Carolina: Retrieved on January 17, 2003, from http://www.shlcgreenville.org/hearing-capd.html

Chermak, G., & Musiek, F. (1992). Managing Central Auditory Processing Disorders in children and youth. *American Journal of Audiology*, 1, 62-65.

Chermak, G. D., & Lee, J. (2005). Comparison of children's performance on four tests of temporal resolution. *Journal of American Academy of Audiology, 16 (8),* 554-563.

Chermak, G. D., & Musiek, F. T. (1997). *Central auditory processing: New perspective.* San Diego: Singular Publishing Group.

Chermak, G. D. (1996). Auditory processing disorder: An overview for the clinician. *The Hearing Journal. 54 (7)*, 10-21.

Chermak, G. D., Somers, K. K., & Seikel, J.A. (1998). Behavioural signs of central auditory processing disorder and attention deficit hyperactivity disorder. *Journal of American Academy of Audiology, 9,* 78-84.

Chermak, G. D., Styers, S. A., & Seikal, J.A. (1995). Study compares the screening tests of central auditory processing. *The hearing journal*, 48(5), 29-33.

Chermak, G.D. (1996). *Central testing.* In S.E Gerber (Ed.). The handbook of peadiatric audiology. Washington, DC: Gallaudet University press.

Cherry, R. (1992). *Screening and Evaluation Of Central Auditory Processing Disorders in Young Children.* In Katz, J., Steccker, N. & Henderson, D. (1992). Central auditory processing: A Transdisciplinary view . Moseby –Year book, Inc

Dawes, P., & Bishop, V. M. (2007). The SCAN-C in testing for auditory processing disorder in a sample of British children. *International journal of Audiology*, 46, 780-786.

Devi, N., Sujitha, N., & Yathiraj, A. (2008). Auditory memory and sequencing in children aged 6 to 12 years, *Journal Of All Indian Institute Of Speech And Hearing* .27, 95-100.

Domitz, D, M., & Schow, R. L. (2000). A new CAPD test battery - multiple auditory processing assessment factor analysis and comparison with SCAN, *American Journal of Audiology*, 9, 101-111.

Emersom, M. F., Crandell, K. K., Seikal, J. A., & Chermak, G. D. (1997). Observation on use of SCAN administered in school setting to identify central auditory processing disorder. *Language, speech and hearing services in schools*, 28, 43-49.

Etymotic research. (2001). BKB SIN Speech-in-Noise test. Eik grove village, IL: Etymotic research.

Etymotic research. (2001). Quick SIN Speech-in-Noise test. Eik grove village, IL: Etymotic research.

Ferre, M. J., & Wilber, A. L. (1986). Normal and learning disabled children's central auditory processing skills: as expriental test battety. Ear and Hearing, 7(5), 336-342.

Humas, L. E. (2005). Do "auditory processing" tests measures the auditory processing in the Elderly ?. *Ear and hearing*, 26(2), 109-119.

Jerger, J., & Musiek, F. T. (2000). Report of the consensus conference on the diagnosis of APD in school aged children. *Journal of American Academy of Audiology* .11(2), 467-474.

Jerger, S. (1981). *Evaluation of central auditory function in children*. In R kith (Ed.), central auditory and language disorder in children. Houston: college-Hill press, Katz, J. (2002). *Handbook of clinical Audiology*. **(**5 Ed**),** Baltimore, MD: Williams & Wilkins.

Keith, R. W. (1995). Developmental and standardization of SCAN-A: A test of auditory processing in adolescents and adults. *Journal of American Academy of Audiology*. 6(4), 286-292.

Keith, R. W. (2000a). Developmental and standardization of SCAN-C for auditory processing in children. *Journal of American Academy of Audiology*. 11(8). 438-445.

Keith, R. W.(1996). Understanding central auditory processing disorder: diagnoisis and remediation, *The Hearing Journal*, 46(11), *19-28.*

Keith, R. W., Rudy, J., Donahau, P. A & Katbamma, B. (1989). Comparison of SCAN results with other auditory and lauguage measures in a clinical population. *Ear and Hearing.* 10, 382-386.

Maggu, A. & Yathiraj, A. (In press). Effect of Speech in noise desensitisation training on children with central auditory processing disorders. *Canadian Journal of Speech, Language Pathology and Audiology.*

Masters, M.G., Stecker, A. N., & K atz, J. (1998), *central auditory processing mostly management*, Allyn & Bacon.

Mayadevi. (1978). *The development and standardization of a common speech discrimination test for Indians.* Unpublished master dissertation, University of Mysore, Mysore.

Musiek, F., Guerkink, N., & Kietel, S. (1982). Test battery assessment of auditory perceptual dysfunction in children .*Laryngoscope*, 92, 251-257.

Musiek, F. T., & Chermak, G. D. (2007). *Handbook of central auditory processing disorder, auditory neuroscience and Diagnosis*.vol:1, San Diego: Purular publishing Group.

Musiek, F. E., Gollegly, K., Lamb, L., & Lamb, P. (1990). Selected issues in screening for central auditory processing of dysfunction. *Seminars in Hearing*, 11, 372-384.

Musiek, F. E., Shinn, J. B., Jirsa, R., Bamiou, D. E., Baran, J. A., & Zaidan, E. (2005). GIN (Gap-In-Noise) test performance in subjects with confirmed central auditory nervous system involvement. *Ear and hearing*, 26(6), 608-618.

Panton, J. W. (n.d). CAPD symptoms and subtypes checklist. Available at http://www.judithpaton.com/checlist.html.

Priya, G., & Yathiraj, A. (2007). *Effect of Dichotic off set training (DOT) in children with (C)APD*. Dissertation submitted as part of fulfillment for the degree of Master of Science, submitted to the University of Mysore.

Purdy, C. S., & Johnstone, C. (2000). *Assessment of central auditory processing disorder, which tests?*. Presented in New Zealand society of audiological conference, Rotora.

Raven, J.C. (1952). *Standard and Coloured progressive matrices: Sets A, AB, B*. Oxford, England: Oxford Psychologists.

Rupp, R. R., & Stockdell, K. G., (1978). *Speech protocols in audiology*, Newyork: Grune & Stratton.

Summer, S. A. (2003). *Factors structure, correlations, and mean data on Form A of the Beta III versions of multiple auditory processing assessment (MAPA).* Master's thesis. Idaho State University, Pocatello.

Rout, A. (1996). *Monosyllabic speech identification Test in English for Indian children.* Dissertation submitted as part of fulfillment for the degree of Master of Science, submitted to the University of Mysore.

Sanger, D. D., Freed, J. M., & Decker, T. N. (1985). Behavioural profile of preschool children suspected of auditory language processing problems. *The Hearing Journal, 10,* 17-20.

Schow , R. L., & Seikal, J. A (2007). *Screening for (central) auditory processing disorder. In Chermak, G. D., Musiek, F. T. (2007). Handbook of central auditory processing disorder, auditory neuroscience and Diagnosis.vol:1,* San Diego: Purular publishing Group.

Schow, R. L., Seikal, J. A., Chermak, G. D., & Barent, M (2000). Central auditory processing and tests measures, ASHA 1996 revised. *American Journal of Audiol*ogy, *9,* 63-68.

Stack, B. A. (1992). *Contraversis in the screening of central auditory processing disoreder. In Bess F, H, Hall JW, (Eds_).* Screening children for auditory function. Nashville, TN: Bill Wilkerson centre Press.

Schow, R. L., & Chermak, G.D. (1999). Implications from factor analysis for central auditory processing disorder. *American Journal of Audiology, 8 (2)*, 137-142.

Schow, R. L., Seikal, J. A., Brockett, E. J., & Whitaker, M. M. (2007). *Multiple auditory processing Assessment (MAPA):* Test Manual, (version1). Idaho state University, Pocatello.

Shiva praskash,S., & Manjula, P. (2003). *Gap Detection Test-development of norms.* Unpublished Master independent Project submitted to the University of Mysore.

Smoski, W. J., Brunt, M. A., & Tannahill, J. C (1992). Listening characteristics of children with central auditory processing disorder, *Journal Of Language, Speech And Hearing Services in Schools,23,* 145-152.

Somski, W. (1990). Use of CHAPPS in a children's in audiology clinic, *Ear and Hearing, 11 (5* supplement): 53S-56S.

Willeford, J. A. (1977). *Assessing central auditory behavior in children: A test battery approach.* In keith. Central auditory dysfunction. New York: Grane & Stratton.

Willeford, J. A., & Burleigh, J. M. (1985). *Handbook of Central Auditory Processing Disorder in children.* Orlando: Grune and Stratton.

Yathiraj, A. (1999). The Dichotic CV test. Unpublished material developed by Dept of Audiology, AIISH, Mysore.

Yathiraj, A., & Mascarenhas, K. (2002). Audiological of profile of the children with suspected processing difficulty. Presented in Indian Speech and hearing conference.

Yathiraj, A., & Mascarenhas, K., (2003). *Effect of auditory stimulation of central auditory processing in children with CAPD*. A project funded by the AIISH research fund.

APPENDIX A

Screening checklist for central auditory processing (SCAP)

Yathiraj and Mascarenhas (2003)

All India Institute of Speech and hearing

Manasagangothari, Mysore-6.

Name: Age/Sex:

Class:

Nos	Questions	Yes	No

Class teacher:

School Name:

Medium of instruction:

Language(s) spoken at home:

Home address and telephone No:

Father’s occupation:

Mother’s occupation:

1	Does not listen carefully and does not pay attention (requires repetition of instruction)		
2	Has a short attention span of listening (appr 5-15mins)		
3	Easily distracted by background sound		
4	Has trouble in recalling what has been heard in the correct order		
5	Forgets what is said in few minutes		
6	Has difficulty in differentiating one speech sound from other similar sound		
7	Has difficulty in understanding verbal instruction and tent to misunderstand what is said which other children of the same age would understand		
8	Show delayed response to verbal instruction or questions		
9	Has difficulty in relating what is heard with what is seen		
10	Poor performance in listening task, but performance improves with visual cues		
11	Has pronunciation problem (mispronunciation of words)		
12	Performance is below average in one or more subjects, such as social subjects, I/II language		

Please place a tick (√) mark against the choice of answer that is most appropriat