Prevalence of central auditory processing disorders and other co-morbid conditions in school going children

by Prawin Kumar P

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PROJECT PROPOSAL FORMAT

Part -A

1.0	**Title of the Project**		Prevalence of central auditory processing disorders and other co-morbid conditions in school going children
1.1	**Area of Research :**		Auditory and Cognition
1.2	**Principal Investigator**		Dr. Prawin Kumar
1.4	**Principal Co-Investigator(s)**		Dr. Niraj Kumar Singh Dr. Hema N.
1.5	**Collaborating Institution**		Nil
1.6	**Total Grants Required (in figures and in words)**		Rs 9, 96, 000 (Nine lakhs ninety six thousands only)
1.7	**Duration of the Project**		One year
2.0	**Project Summary** (Max. 300 words)		Details enclosed.
3.0	**Introduction** (under the following heads)		More details in the actual proposal
	3.1 Definition of the problem	:	In last few decades, the identification of central auditory processing disorders received considerable attention because evidences indicated that central auditory processing difficulties may be related to school performance. However, this relationship is questionable because of number of factors which includes the heterogeneous nature of central auditory processing disorders and the lack of true prevalence of central auditory processing disorders. Further this could also be due to lack of gold standard test to identify the disorders.
	3.2 Objectives	:	Enclosed
	3.3 Review of status of research and development in the subject	:	Enclosed
	3.4 International and national status	:	Enclosed
	3.5 Importance of the proposed project in the context of current status	:	The outcome of the study will provide helps us to know the prevalence of CAPD and other co-morbid disorders in

school going children.

4.0 Work Plan

4.1 Method

Subjects / Participants	:	Minimum 1000 school going children will be screened to find out at risk children with CAPD and other co-morbid disorders.
Material	:	Clinical Audiometer, DMDX software for assessing CAPD and other co-morbid disorders
Procedure	:	Behavioural CAPD test.
Analyses	:	Association between CAPD and other co-morbid disorders in school going children.

PREVALENCE OF CENTRAL AUDITORY PROCESSING DISORDERS AND OTHER CO-MORBID CONDITIONS IN SCHOOL GOING CHILDREN

Project Summary

In last few decades, the identification of central auditory processing disorders received considerable attention because evidences indicated that central auditory processing difficulties may be related to school performance (Cruickshank, 1981; Hurley & Singer, 1985; Katz, 1992; Lasky & Katz, 1983; Musiek & Chermak, 2011). However, this relationship is questionable because of number of factors which includes the heterogeneous nature of central auditory processing disorders and the lack of true prevalence of central auditory processing disorders (Stach, 1992). The wide variation could be due to heterogeneity of the present disorders as well as no gold standard test to identify the disorders, a test battery approach is encouraged (Vanniasegaram et al., 2004). However, there are no consistencies in the different types of auditory tests that are used by different professionals and hence the questions regarding the validity of diagnosis of auditory processing disorders have been raised even when testing has been consistent (Cacace & McFarland, 1998). Due to the above reason, present study is taken up

to find out the children who exhibit the symptoms of central auditory processing disorders alone or other co-morbid disorders symptoms such as reading disorders, attention deficit, cognition deficit, language disorders and autism. Further, the association between auditory processing disorders with other co-morbid disorders will also be explored in the present study. The aim and objective of the present study is to estimate the prevalence of children with central auditory processing disorders and association with other co-morbid disorders in school going children. Tests for central auditory processing disorder (CAPD), language disorders, cognitive ability and reading disorder will be administered on all children to find out the symptoms of central auditory processing disorders alone or other co-morbid disorders symptoms such as reading disorders, attention deficit, cognition deficit, language disorders and autism.

Introduction

There is a wide variation in estimating the correct identification of central auditory processing disorders and association with other co-morbid disorders such as reading disorders (Dawes et al., 2008; Sharma et al., 2009; Dawes & Bishop, 2010), attention deficit, cognition deficit, specific language impairment (Ferguson et al., 2011), and autism (Dawes et al., 2008; Dawas & Bishop, 2010) in school going children. Study done by Hind et al., 2011 reported that around 0.5 to 1% of children and adults have listening difficulties despite normal audiograms. These children and adults may be considered having auditory processing disorders (Ferguson et al., 2011; Hind et al., 2011). In another study the prevalence of auditory processing disorders estimated to be approximately 7% in childhood (Bamiou, Musiek, & Luxon, 2001). In addition, Chermak and Musiek in year 1997 reported auditory processing deficit to be present in 2 to 5 % of school going children (Chermak & Musiek, 1997). In another study, Roop and Stockdell (1978) were noticed language deficit in 15 to 20 % of school going children. Out of these, 70% had some kind of auditory based problems.

In India, Ramaa (1985) found the incidence of learning disability in 3% school going children. Similarly, study done by Muthuselvi and Yathiraj in 2009 were also found around 3.2% children at risk for CAPD out of 3120 school going children based on screening checklist of

auditory processing questionnaires. Children with central auditory processing disorders exhibit poor auditory skills like difficult to follow the oral instruction, difficult to understand the speech in background noise. It usually co-exists with learning difficulty, language problem, reading, writing and spelling errors (Mcarthur & Bishop, 2004a; 2004b; ASHA 2005).

Indeed, epidemiological studies estimate the incidence of specific language impairment (SLI) to be approximately 7.4% in a population of monolingual English-speaking kindergarten children (Tomblin et al., 1997) even if the severe cases are probably not more than 1%. Children with SLI exhibit deficits in several aspects of language, including phonology, morphology and syntax (Bishop & Leonard, 2000; Bishop & Snowling, 2004). One of the hallmarks of SLI is a deficit in the use of function morphemes (e.g., the, a, is) and other grammatical morphology (e.g., past tense -ed). Children with SLI are also at high risk for subsequent literacy problems (McArthur, Hogben, Edwards, Heath, & Mengler, 2000).

Nonlinguistic deficits in either perception or memory are thought to be responsible for language disorder (e.g., Wright, Bowen, & Zecker, 2000). The most prominent theory of this kind, also called the ''fast temporal-processing deficit,'' maintains that SLI is a consequence of a deficit in processing brief and/or rapidly changing auditory information and/or in remembering the temporal order of auditory information (Merzenich et al., 1996; Tallal & Piercy, 1973, 1974, 1975). For example, Tallal and Piercy (1973) found that some children with SLI have difficulty in reporting the order of pairs of high- and low-frequency sounds when these sounds are brief in duration and presented rapidly.

The auditory deficit account has been criticized because many children with SLI perform normally on a variety of auditory tasks (Bailey & Snowling, 2002) and because auditory deficits do not predict much of the variance within the group of language-impaired children (Rosen, 2003). In addition, a number of studies have shown that auditory deficits are not restricted to rapid auditory processing (Marshall, Snowling, & Bailey, 2001). To the contrary, many ''slow'' tasks, such as those based on the auditory processing of slow (e.g., 4 Hz) amplitude modulations, seem to be difficult for children with developmental language learning disorders.

There is some evidence that memory deficits may underlie difficulties with listening in noise (Alloway & Gathercole, 2005; Montgomery, Magimairaj, & Finney, 2010; Nelson &

Warrington, 1980). Auditory short-term and working memory skills likely facilitate speech understanding in the presence of noise by allowing the listener to temporarily store and actively process the auditory information to link related information across time and to form coherent representations while ignoring irrelevant distractions (Arlinger, Lunner, Lyxell, & Pichora-Fuller, 2009; Kraus, Strait, & Parbery-Clark, 2012; Pichora-Fuller, Schneider, & Daneman, 1995). This is consistent with earlier studies conducted on adult listeners indicating that the performance on speech recognition in competing speech is strongly correlated to verbal working memory skills (Kraus et al., 2012; Meister et al., 2013; Rudner, Lunner, Behrens, Sundewall Thorén, & Rönnberg, 2012).

The recommended clinical test battery used by audiologists to evaluate children with listening difficulties usually encompasses a wide range of auditory processing and cognitive skills (Emanuel, 2002; Jerger & Musiek, 2000; Musiek et al., 2010). Auditory attention is an important factor influencing the ability to listen in the presence of background noise (Fritz, Elhilali, David, & Shamma, 2007; Sturm, Willmes, Orgass, & Hartje, 1997). Evidence for attention deficits in children with listening difficulties has been shown in two recent studies (Dhamani, Leung, Carlile, & Sharma, 2013; D. R. Moore, Ferguson, Edmondson-Jones, Ratib, & Riley, 2010). Auditory attention includes phasic alertness, sustained attention, selective attention, and attention switching ability (Gomes, Molholm, Christodoulou, Ritter, & Cowan, 2000; Sturm et al., 1997).

Some studies report that listeners with dyslexia and language impairment also have difficulty listening in background noise (Alcántara, Weisblatt, Moore, & Bolton, 2004; Ziegler, Pech-Georgel, George, & Lorenzi, 2009, 2011). These populations reportedly demonstrate deficits in auditory stream segregation (Démonet, Batty, Chaix, & Taylor, 2006; Helenius, Uutela, & Hari, 1999; Lepistö et al., 2009), frequency resolution (Halliday & Bishop, 2006; McArthur & Bishop, 2004), and temporal envelope processing (CohenMimran & Sapir, 2007; Rocheron, Lorenzi, Füllgrabe, & Dumont, 2002).

There is, however, debate over the validity and reliability of commonly used auditory processing disorders assessments, definition, and possible misidentification of learning problems as auditory processing disorders. It has been suggested that auditory processing disorders is not a separate disorder but rather is a reflection of an attention deficit, a learning disability or a

language disorder. It has also been suggested that the diagnosis a child receives is partly dependent on the professional who assesses them. In other words, an audiologist would diagnose auditory processing disorders in cases where an educational psychologist or speech therapist would diagnose dyslexia or specific language impairment (Friel-Patti, 1999). Note that auditory processing problems may co-occur with specific learning disabilities, and it is suggested that they may be causally related according to a study by Talla (2004). The significance of auditory processing difficulties is one that has been widely researched and remains controversial (Rosen, 2003; Dawes & Bishop, 2009).

Need for the study

In last few decades, the identification of central auditory processing disorders received considerable attention because evidences indicated that central auditory processing difficulties may be related to school performance (Cruickshank, 1981; Hurley & Singer, 1985; Katz, 1992; Lasky & Katz, 1983; Musiek & Chermak, 2011). However, this relationship is questionable because of number of factors which includes the heterogeneous nature of central auditory processing disorders and the lack of true prevalence of central auditory processing disorders (Stach, 1992). The wide variation could be due to heterogeneity of the present disorders as well as no gold standard test to identify the disorders, a test battery approach is encouraged (Vanniasegaram et al., 2004). However, there are no consistencies in the different types of auditory tests that are used by different professionals and hence the questions regarding the validity of diagnosis of auditory processing disorders have been raised even when testing has been consistent (Cacace & McFarland, 1998). Due to the above reason, present study is taken up to find out the children who exhibit the symptoms of central auditory processing disorders alone or other co-morbid disorders symptoms such as reading disorders, attention deficit, cognition deficit, language disorders and autism. Further, the association between auditory processing disorders with other co-morbid disorders will also be explored in the present study.

There have also been suggestions that a proportion of children who complain of listening difficulties especially in noise may have deficits in auditory processing (Bamiou, Musiek, & Luxon, 2001; Lagacé et al., 2010; Moore et al., 2013). Auditory processing is an umbrella term encompassing a variety of auditory skills. Clinical guidelines suggest evaluating localization, lateralization, auditory discrimination, auditory temporal processing, auditory pattern processing,

dichotic auditory performance in competing acoustic signals, and auditory performance with degraded acoustic signals (Musiek et al., 2010). There is a need to test for auditory processing deficits using a set of clinical tests available with normative to identifying which auditory processing abilities may be linked to the individuals with co-morbid conditions like specific language impairment, learning disability, attention and concentration deficit and autism.

Aim of the Study

The aim of the present study is to estimate the prevalence of children with central auditory processing disorders and association with other co-morbid disorders in school going children.

Objective of the study

- To estimate the prevalence of central auditory processing disorders alone in school going children.
- To estimate the prevalence of central auditory processing disorder along with other comorbid disorders in school going children.

Method

Participants

There will be minimum 1000 children from five different schools in Mysore city will be considered for the screening in the age range of 8–15 years for the present study. They should be undergoing formal education with the medium of instruction being English/Kannada. All participants should have normal hearing sensitivity (250–8000 Hz) on clinical evaluation. The proficient language of all the participants had to be Kannada (Mother tongue). The other languages could be English (most frequently used/or medium of instruction at school/college) and/or Hindi and/or Tamil. All these participants should belong to a middle/high socioeconomic status. None of the participants should have middle ear pathology at the time of testing, which

will be confirmed by clinically normal findings based on otoscopy, tympanometry, pure tone audiometry, and acoustic stapedial reflex thresholds. Those participants who will have a history or formal diagnosis of attention-deficit/hyperactivity disorder will be excluded from this study. They should be free from any neurological or psychological illness as determined by General Health Questionnaire (Golderberg & Williams, 1988).

Instrumentation

A calibrated Grason-Stadler Incorporated 61(Grason Stadler, Eden Prairile, USA) dual-channel audiometer with Telephonics TDH-49 headphones will be used for obtaining pure tone audiometry and speech audiometry. A calibrated Grason-Stadler Incorporated Tympstar (Grason Stadler, Eden Prairile, USA) immittance meter will be used for tympanometry and reflexometry. The above GSI-61 audiometer will also be used for central auditory processing disorders tests.

Test Environment

The tests for the study will be carried out in an acoustically treated air-conditioned room (ANSI S3.1, 1999) with adequate illumination. Pure tone audiometry and speech audiometry will be carried out in a two-room set up while tympanometry and click evoked ABR will be administered in a single room suite. Further, screening tests for auditory processing will be done in quiet environment.

Test materials

Tests for Central Auditory Processing Disorder (CAPD), language disorders, cognitive ability and reading disorder will be administered on children at risk for CAPD from different schools at Mysore city.

1. **Tests for central auditory processing disorders**

- Dichotic CV test: Gowri and Yathiraj (2001)
- Gap detection test: Shivaprakash and Manjula (2003)
- Duration pattern test: Gowri and Manjula (2004)
- Masking level difference (MLD) test

- Speech in noise test

2. **Tests for language disorders**

- Bankson Language screening test- Provides examiners with a measure of children's psycho-linguistic skills. The device is organized into three general categories that assess a variety of areas: Semantic Knowledge-body parts, nouns, verbs, categories, functions, prepositions, opposites; Morphological/Syntactical Rules-pronouns, verb usage/verb tense, verb usage (auxiliary, modal, copula), plurals, comparatives/superlatives, negation, questions; and Pragmatics-ritualizing, informing, controlling, and imagining.
- Linguistic profile test (Karant, 1980) - Assess syntactic and semantic aspects of language under the headings like semantic discrimination, naming, lexical category, synonym, antonym, homonymy, polar questions, semantic anomaly, paradigmatic & syntagmatic relations, semantic contiguity and similarity under semantics. In Syntax, morphophonemic structures, plurals, tenses, PNG markers, case markers, transitives, intransitives, causatives, sentence types, conjunctives and quotatives, comparatives, conditional clauses and participle construction.

3. **Tests for cognitive ability**

- Mini-mental status examination (MMSE)
- Digit span task
- *Selective attention and attention switching* task using DMDX software
- *Sustained attention and memory-* The Clinical Evaluation of Language Fundamentals, Fourth Edition (Semel et al., 2003) – The first level of testing measures general language ability, determines the presence or absence of language disorder, and assesses appropriateness of service by quantifying performance. The four subtests at this level make up the Core Language Score (CLS), the foundational score from which any or all of three pathways may be taken to provide more in-depth information. Subsequent levels of testing examine (a) the nature of language disorder, (b) behaviors associated with the language disorder, and (c) the effect of the language disorder on classroom functioning.

4. **Test for reading disorders**

- Early Reading Skill test

Procedure

The study will be carried out in two stages i.e. stage I and II. Stage I will includes the questionnaire based screening tests for auditory processing and audiological test as screening test for auditory processing to identify children at risk for central auditory processing disorders. Based on the pass and fail criteria of the above tests, children will be recruited for stage II for detailed evaluation to identify children with central auditory processing disorders and co-morbid disorders. Tests for stage II will include pure tone audiometry, speech audiometry, immittance evaluation, test for auditory processing disorders, cognition test, language tests, and test for autism.

Stage I

Screening Checklist for Auditory Processing (SCAP) which was developed by Yathiraj and Mescarhenus (2003) will be used for the present study. The above questionnaire based checklist will be used for different English medium schools in Mysore city, Karnataka. SCAP will be administered by teacher under the close supervision of Audiologist at school. The feedback from the teacher/parents will also be obtained for those children who will fail in the test. In SCAP, each question will be explained and then they will be asked to select yes or no options available for each question. If they will be having aggregate score of greater than 6 as 'Yes' response then they will be considered as fail in screening test for auditory processing and will be referred for audiological screening test i.e. screening test for auditory processing (STAP).

Screening test for auditory processing (STAP) was developed by Yathiraj and Maggu (2012) in Indian population, which include four subsections i.e. speech-in-noise-test in Indian English, dichotic consonant vowel test, gap detection test and auditory memory test. STAP will be administered using personal computer with headphone at most comfortable loudness levels to find out children at risk for (C)APD. The referral will be made based on the criteria recommended by the developer for STAP test for at risk for CAPD. Those children who will

identified as at risk for central auditory processing disorders in stage I will be considered for stage II evaluation.

Stage II

Stage II will include tests as basic audiological evaluation, test for the confirmation of central auditory processing disorders, language test, attention tests and test for autism. Basic audiological tests include pure tone audiometry, speech audiometry, immittance evaluation, tone burst otoacoustic emission and click evoked auditory brainstem responses, which will be carried out on all children who will be identified as at risk for central auditory processing disorders.

Pure-tone thresholds will be obtained using modified Hughson and Westlake procedure (Carhart & Jerger, 1959) at octave frequencies from 250 Hz to 8000 Hz for air- conduction and between 250 Hz to 4000 Hz for bone-conduction stimulation. Speech recognition score will be estimated using the standardized paired-word list in the participants' native language. Speech identification score will be obtained at 40 dB above SRT using the standardized phonemically balanced (PB) word lists in the participants' native language. Using a 226 Hz probe-tone at 85 dB SPL, the tympanogram will be obtained by varying the air pressure in the ear canal from +200 to -400 daPa. Ipsilateral and contralateral acoustic reflex thresholds will be obtained at octave frequencies from 500 to 4000 Hz using the same probe-tone frequency as mentioned above. Transient evoked otoacoustic emissions (TEOAEs) will be measured using Echoport ILO (Version 6). A standard TEOAE probe tip will be positioned in the individual's ear canal. The presence of TEOAE responses will be based on above 80% overall reproducibility and signal-to-noise ratio above 6 dB for at least two consecutive frequencies in between 500 Hz to 4000 Hz.

Click evoked auditory brainstem response will be done to rule out retro-cochlear pathology on those children who will be identified as at risk for central auditory processing disorders. The click evoked ABR will be done monaurally at repetition rate of 30.1/s, rarefaction polarity using single channel recording. The band pass filter will be 100 to 1500 Hz and the intensity level will be at 80 dB HL.

The early reading scale (ERS) test will be used to evaluate the reading ability of the school going children from grade 1 to grade VIII. Early reading skill test will be administered on

those children who will be at risk for central auditory processing disorders based on SCAP and STAP.

Statistical Analysis

The statistical analysis will depend on the data collected from the participants. Depending upon the distribution of the data, either parametric or non-parametric test will be administered. The descriptive statistics will be done to find out mean and standard deviation for the children with CAPD alone and in co-morbid conditions. Further, the association between CAPD and other co-morbid condition will be analyzed using appropriate statistical tools i.e. spearman correlation analyses.

Implication of the study

The knowledge of prevalence of CAPD and other co-morbid conditions in school going children will help the professional to develop further detailed assessment and management tools for children with CAPD alone and other co-morbid disorders.

Prevalence of central auditory processing disorders and other co-morbid conditions in school going children

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