Early Recurrent Otitis Media, Language and Central Auditory Processing in Children

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ABSTRACT

The study examines the relationships that exist between early recurrent otitis media, language and central auditory processing in children. A retrospective case-control experimental design was employed and ten subjects were allocated to each of the two research groups, namely children with a history of early recurrent otitis media (research group 1) and children without a history of early recurrent otitis media (research group 2). The children in both research groups were in grade one and turning 7 years old. The language and central auditory processing of the subjects were assessed using the Clinical Evaluation of Language Function (Wiig & Semel, 1980) and the Willeford Battery of Central Auditory Function (Willeford, 1974). The results showed that the language and central auditory processing of the children with a history of early recurrent otitis media were significantly poorer than that of their disease-free peers. The results stress the importance of vigorous identification and management programmes for children with a history of early recurrent otitis media.

OPSOMMING

Hierdie studie bestudeer die verhoudings wat bestaan tussen vroeë herhaalde otitis media, taal en sentrale ouditiewe prosessering in kinders. 'n Terugkykende geval-beheer eksperimentele navorsingsontwerp is gebruik en tien proefpersone is toegesê aan elkeen van die twee navorsingsgroepe, naamlik kinders met 'n geskiedenis van vroeë herhaalde otitis media (navorsingsgroep 1) en kinders sonder 'n geskiedenis van vroeë herhaalde otitis media (navorsings-groep 2). Die kinders in beide navorsingsgroepe was in graad een en sou sewe jaar oud word. Die taal en sentrale ouditiewe prosessering van die proefpersone is geëvalueer met behulp van die "Clinical Evaluation of Language Function" (Wiig & Semel, 1980) en die "Willeford Battery of Central Auditory Function" (Willeford, 1974). Die resultate toon dat die taal en sentrale ouditiewe prosessering van die kinders met 'n geskiedenis van vroeë herhaalde otitis media betekenisvol swakker was as vir die kinders sonder 'n geskiedenis van vroeë herhaalde otitis media. Die resultate beklemtoon die belangrikheid van kragtige identifiserings- en behandelingsprogramme vir kinders met 'n geskiedenis van vroeë herhaalde otitis media.

KEY WORDS: early recurrent otitis media, language and central auditory processing.

Otitis media, an inflammation of the middle-ear which may or may not be infectious in origin, is one of the most prevalent diseases in childhood (Friel-Patti, 1990). The degree of the conductive hearing loss associated with otitis media is variable, ranging from less than 10dBHL to as much as 50dBHL (Friel-Patti, 1990; Gravel & Ellis, 1995). Otitis media usually affects both ears and may be continuous, causing a constant reduced level of hearing or it may be recurrent, causing a fluctuating hearing loss (Northern & Downs, 1984; Gravel & Ellis, 1995). The child with a history of early recurrent otitis media or the otitis prone child was first described by Howie, Ploussard and Sloyer (1975) as having six or more episodes of otitis media before six years of age.

Although otitis media has been a recognised concern for health-care professionals, the short- and long-term consequences of early recurrent otitis media and the accompanying, usually temporary, hearing loss for child development are less well understood (Friel-Patti, 1990; Roush & Henderson, 1995). Children with a history of early re-

current otitis media are reportedly seen more often than their peers by the speech-language pathologist and audiologist for language and central auditory processing disorders (Collazo & Kricos, 1986; Paden, 1994). Shriberg & Kwiatowski (1982, cited in Friel-Patti, 1990) have estimated that one-third of children seen by the speech-language pathologist and audiologist have a history of early recurrent otitis media. A review of the literature does however, yield mixed support for associations between early recurrent otitis media and language disorders in children. Although there is strong support in the literature for associations between early recurrent otitis media and central auditory processing disorders, this evidence is largely based on the results of animal studies (Tees, 1967; Clopton & Silverman, 1978; Webster, 1983) and a limited number of human studies (Folsom, Weber & Thompson, 1983; Finitzo, Gunnarson & Clark, 1990; Hurley & Hurley, 1995).

Central to the relationships that exist between early recurrent otitis media and language disorders, and early recurrent otitis media and central auditory processing disorders, is the hypothesis of a critical period for language acquisition and the development of the central auditory nervous system. The essential prediction from the critical period hypothesis is that the timing of any adverse experience (such as the fluctuating hearing loss associated with early recurrent otitis media) will be crucial and that after a certain age, the ability to acquire language and central auditory processing skills diminishes so that any deficits remaining at the end of this period are unlikely to be overcome (Mogford & Bishop, 1988; Gravel & Ellis, 1995). The notion of a critical period for language acquisition was first proposed by Penfield (1965). Although there is consensus in the literature that the critical period for language acquisition starts at birth, the upper limit of this period remains controversial (Mogford & Bishop, 1988). Lenneberg (1967) estimates the upper limit at puberty while Krashen (1973, cited in Mogford & Bishop, 1988) estimates the upper limit at five years of age. The upper limit of the critical period for the development of central auditory nervous system is also controversial and estimates vary from two years of age (Northern & Downs, 1984) to approximately twelve years of age (Welsh, Welsh & Healy, 1983; Keith, 1988). The upper limits of the critical period for language acquisition and the development of the central auditory nervous system are thus poorly understood at this time (Mogford & Bishop, 1988).

Firstly, with regard to the influence of early recurrent otitis media on language development, there are a large number of studies describing the influence of early recurrent otitis media on language acquisition. One of the earliest and most publicized studies describing the negative impact which early recurrent otitis media has on language development in children was documented by Holm and Kunze (1969). Since this study, research findings have reported general delays in speech and language development (Zinkus, Gottlieb & Schapiro, 1978; Jerger, Jerger, Alford & Abrams, 1983); lower performance on auditory perceptual and language processing tests (Zinkus et al., 1978; Brandes & Ehinger, 1981; Eimas & Clarkson, 1986); a higher incidence of academic problems, especially reading and spelling disorders; lower scores on tests of phoneme production in connected speech as well as the use of combinations of phonemes in word endings (Needleman, 1977); and a higher frequency of enrolment in special support classes in schools (Brandes & Ehinger, 1981) as well as in speech and language therapy programmes (Collazo & Kricos, 1986).

There are, however, studies that have yielded mixed support for associations between early recurrent otitis media and language disorders in children. Owrid (1970) found that children with a history of otitis media (but whose hearing was normal at the time of testing) suffer minor, if any, deficit in terms of vocabulary, language comprehension, syntax and reading level. Roberts, Sanyal, Burchinal, Collier, Ramey and Henderson (1986) found no significant correlations between early recurrent otitis media and outcome measures of standardized test scores for both verbal and non-verbal intelligence and academic functioning. In 1988, in a second study with the same group of children (as used in the study of Roberts et al., 1986) which included speech measures of phonological process analysis and articulation testing, no significant relationship was found between early recurrent otitis media and the number of consonants in error or the number of phonological processes used (Roberts, Burchinal, Koch, Footo & Henderson, 1988). However, Feagans, Sanyal, Henderson, Collier and Applebaum (1987) again using the same sample as Roberts et al. (1986), found a correlation between early recurrent otitis media and narrative ability, but no relationship for early recurrent otitis media and mean length of utterance.

The extent to which early recurrent otitis media can be held responsible for impaired language development in children thus remains an unresolved issue. The above opposing positions to the relationship between early recurrent otitis media and language development can possibly be attributed to the differences and limitations in the research methodologies employed in the above studies (Paden, 1994). Firstly, the subject sample is often too small to permit generalizations. Secondly, definitions of the otitis prone condition vary. Thirdly, the age at which the subjects were assessed vary and the subject sample is often too small to permit generalizations. Fourthly, most of the studies concentrated on one area of speech or language but left others unexplored and finally, other variables such as mental retardation, hearing acuity, exposure to more than one language, history of neurological dysfunction and social-domestic problems which may influence measures of language are not always accounted for (Mogford & Bishop, 1988; Paden, 1994). Further research, which considers the above criticisms, is thus necessary to determine the impact, if any, which early recurrent otitis media has on language acquisition in children.

Secondly, with regard to the influence of early recurrent otitis media on central auditory processing, evidence from animal studies (Tees, 1967; Clopton & Silverman, 1978; Webster, 1983) has been used to show that periods of auditory deprivation, occurring during a time when the maturational processes of the central auditory pathways are not complete, may result in abnormal development of these pathways. This evidence has taken the form of small but demonstrable neuro-anatomic differences in the brainstem, abnormalities in the higher brainstem electrophysiologic responses (Clopton & Silverman, 1978), differences in auditory electrophysiologic studies on binaural interaction tasks, and differences in the behavioural responses to complex sound (Tees, 1967).

By way of analogy with animal studies, it has been suggested that auditory deprivation (including the fluctuat-

ing hearing loss associated with early recurrent otitis media) may have a negative influence on the central auditory nervous system in humans (Downs, 1988). There are, however, disadvantages in the application of the results of animal studies to the developing human auditory system: Firstly, the description of a critical period during which the neural system demonstrates plasticity cannot be directly transferred to human development and secondly, the animals used in the above experiments were operatively given constant conductive hearing impairments during specified periods of time and inferences made with respect to the effects of the fluctuating hearing loss associated with early recurrent otitis media are thus speculative.

The limited number of human studies available provide strong evidence to support a correlation between early recurrent otitis media and central auditory processing disorders in children. Folsom et al. (1983) found significantly greater absolute wave III and V latencies, and I to III and III to V interpeak latencies for children with a history of early recurrent otitis media which suggest subtle differences in brainstem transmission. These findings are consistent with those of Finitzo et al. (1990) who also found differences in the middle latency response of children with a history of early recurrent otitis media. The results of the above studies thus provide evidence for associations between early recurrent otitis media and central auditory processing disorders at brainstem and cortical level.

In an interesting and relevant study reported by Welsh et al. (1983), a group of 35 children with a history of otitis media were assessed using the Willeford Battery of Central Auditory Function (Willeford, 1974). This battery of tests consists of two cortical procedures (the Competing sentence test and the Filtered speech test) and two brainstem procedures (the Binaural fusion test and the Rapidly alternating speech perception test). The results showed that 75 percent of the subjects failed one or more of the four tests. The performance of the subjects was also found to be significantly lower for the Competing sentence test, the Filtered speech test and the Binaural fusion test than for the Rapidly alternating speech perception test. The results of Welsh et al.'s (1983) study thus provide evidence for associations between early recurrent otitis media and central auditory processing disorders at brainstem and cortical level and are consistent with the findings of Folsom et al. (1983) and Finitzo et al. (1990). A critisism that can be directed at the study of Welsh et al. (1983) is that "the child with a history of otitis media" is not clearly defined.

More recently, Hurley and Hurley (1995) have investigated the effect of otitis media on brainstem electrophysiology using matched experimental and control groups. At the time of the testing all the subjects were free of otitis media and had a discernible auditory brainstem response to clicks at 25dBHL. The results showed that the absolute wave III and V latencies of the experimental group were significantly longer than those of the control group. In addition, the I to V interpeak latency of the experimental group was significantly delayed in comparison to the control group.

Despite strong evidence in the literature for associations between early recurrent otitis media and central auditory processing disorders at brainstem and cortical level, further research is necessary to substantiate the results of the limited number of human studies available.

The rationale underlying the study is to examine the relationships that exist between early recurrent otitis media and language and early recurrent otitis media and central auditory processing in children. The results of the study will help the speech-language pathologist and audiologist to determine whether children with a history of early recurrent otitis media are a greater risk for developing language and central auditory processing disorders than their peers.

METHODOLOGY

AIMS OF THE STUDY

The main aim of the study is to investigate the influence of early recurrent otitis media on language development and central auditory processing in children. This aim is realized in the following sub-aims:

1. To assess the language and compare the intergroup tendencies of the language of each research group of subjects, namely children with a history of early recurrent otitis media (research group 1) and children without a history of otitis media (research group 2).
2. To assess the central auditory processing and compare the intergroup tendencies of the central auditory processing of each research group of subjects.

RESEARCH DESIGN

A retrospective case-control experimental design (Roberts & Schuele, 1990) was employed to observe whether patterns and relationships exist between early recurrent otitis media and language impairment, and early recurrent otitis media and central auditory processing disorders in children.

SUBJECTS

Seventy-two questionnaires were distributed to five English medium primary schools in Pretoria. The five primary schools that participated in the study, were selected as there was already an established relationship between the staff at these schools and the staff at the Department of Communication Pathology at the University of Pretoria. This Department provides a community service programme that entails screening the hearing and middle-ear functioning of children at these schools on an annual basis. The advantage of using these schools was that greater cooperation could be expected from the staff and thus the parents (all the questionnaires distributed were completed and returned).

The information used to identify possible candidates was obtained from the questionnaires completed by the parents of the children, the school records and personnel declaration. The subject selection criteria included in the study are in accordance with Paden's (1944) recommendation that variables such as age, scholastic level, sex, socio-economic status, intelligence and hearing be controlled when researching the influence of early recurrent otitis media on child development. Possible candidates were required to be in grade one (and turning 7 years old). Children in grade one (and turning 7 years old) were selected to fascilitate the identification of children with and without a history of early recurrent otitis media in accord-

ance with Howie et al.'s (1975) definition of the "otitis prone" child namely as having six or more episodes of otitis media by 6 years of age. Furthermore, possible candidates were required to use English as their home language and medium of formal education, to have average to above-average cognitive abilities, to have no history of neurological dysfunction or symptoms, to have a middle to higher socio-economic background, to have no emotional or social-domestic problems, and finally to have normal hearing (air-conduction thresholds between 0 and 15 dBHL for the frequency range 125-8000 Hz) and normal middle-ear functioning (type A tympanograms with a middle-ear pressure of between -100 and +50 daPa, and a static compliance of between 0,3 and 1,75 cm^3). The normative data used to interpret the above audiometric test results is based on the norms recommended by Northern & Downs (1984) and Keith (1988). The subject selection criteria and parameters are presented in Table 1.

Sixteen possible candidates were identified for research group 1 (children with a history of early recurrent otitis media) and twenty-nine possible candidates were identified for research group 2 (children without a history of early recurrent otitis media). Possible candidates for research group 1 were also required to satisfy Howie et al.'s (1975) definition of the "otitis prone" child. Twenty subjects were then selected using the table of random numbers method (Roberts & Schuele, 1990), and ten subjects were allocated to each research group with an even distribution of five males and five females per group.

APPARATUS AND MATERIAL

- ***Apparatus and material used to identify possible subjects***

- **Questionnaire**

A questionnaire was developed to identify children who met the subject selection criteria and thus possible candidates for the study. The areas covered in the questionnaire included the child's name and age, home language, history of otitis media and medical history.

Table 1: Subject selection criteria and parameters

Subject selection criteria	Research Group 1	Research Group 2	References that advocate inclusion of criteria
Criteria that remained constant:			
· Age	Mean age: 6 years 7 months	Mean age: 6 years 8 months	Paden (1994)
· Scholastic level	Grade one	Grade one	Paden (1994)
· Home language and medium of formal education	English	English	Paden (1994)
· Cognitive abilities	IQ above 100	IQ above 100	Paden (1994)
· Neurological functioning	No neurological dysfunction	No neurological dysfunction	Paden (1994)
· Socio-economic background	Middle to higher background	Middle to higher background	Paden (1994)
· Emotional and social-domestic issues	No emotional or social-domestic problems	No emotional or social-domestic problems	Paden (1994)
· Sex	5 males and 5 females	5 males and 5 females	Paden (1994)
· Hearing	Mean puretone average: left ear = 0dBHL and right ear = 5dBHL	Mean puretone average: left ear and right ear = 5dBHL	Northern & Downs (1984)
· Middle ear function	Type A tympanogram	Type A tympanogram	Northern & Downs (1984)
Criterium used to differentiate between groups			
· Six or more episodes of otitis media by age six	Range of episodes: 6 to 15 at time of testing, mean : 8 episodes	Mean : 0 episodes	Howie et al. (1975)

- **Audiometric equipment**

A GSI-10 Audiometer and GSI-33 Middle Ear Analyzer were used to assess hearing acuity and middle-ear functioning prior to the assessments of language and central auditory processing. A sound-proof testing booth and Telephonic TDH-50 earphones with MX 41/AR cushions were used. The audiometer and middle-ear analyser were calibrated according to the SAB 0154 - 1979 requirements.

- **Apparatus and material used in the evaluation of study groups 1 and 2**

- **The Clinical Evaluation of Language Function (Wiig & Semel, 1980)**

The CELF was selected as this language assessment procedure provides differential measures of selected language functions in the area of phonology, syntax, semantics, memory, word-finding and retrieval. These measures have thus been designed to probe specific areas of language processing and production abilities as well as the ability to process and produce speech sounds in school-age children. A summary of the CELF subtests is provided in Appendix A. All the subtests of the CELF were administered with the exception of the Word series subtest. The Word series subtest was not administered as Wiig and Semel (1980) stipulate (in their test manual) that this subtest should not be administered to children younger than 8 years of age.

A drawback to the choice of the CELF for assessing the language of the subjects in the study is the fact that the CELF has been compiled and standardized for children living in the United States of America (USA) and not children living in the Republic of South Africa (RSA). There is, however, no equivalent measure of language ability with norms available for the RSA population. It is of concern to note that most of the diagnostic measures used in the RSA for research and clinical diagnosis have been obtained from other countries, and the norms are thus not necessarily representative of the RSA population. Furthermore, certain words and language structures are specific to different countries and may thus not be familiar to other groups. Although the language structures included in the CELF should be familiar to the RSA population, there are a few words such as "sneakers", "candy" and "drugstore" that do not form part of South-African English. As the aim of the study was to assess the language and compare the intergroup tendencies of each experimental group (and not the applicability of the CELF norms to the RSA population) it was decided to use the CELF without any adaptations or changes to the test items but to familiarize the subjects with the unfamiliar words prior to the testing (by explaining the meanings of the words and asking the subjects to repeat the words). A list of the words with which the subjects were familiarized is presented in Appendix B.

- **The Willeford Battery of Central Auditory Function (Willeford, 1974)**

The Willeford Battery of Central Auditory Function was selected as this battery of tests provides normative data for children from the age of five years and consists of four separate procedures for assessing central auditory processing. Two of the procedures have been designed to assess cortical function and two to assess the integrity of the brainstem. The cortical procedures are the Competing sentence test and the Filtered speech test. The brainstem measures are the Binaural fusion test and the Rapidly alternating speech perception test. The Willeford Battery of Central Auditory Function (Willeford, 1974) was purchased from Professor J A Willeford and consists of an audio-cassette with the test stimuli, a test manual and normative data. A summary of the tests of the Willeford Battery of Central Auditory Function is provided in Appendix C.

The drawbacks to the choice of the Willeford Battery of Central Auditory Function for assessing the central auditory processing of the subjects in the study are firstly, that this battery of tests has been compiled and standardized for the USA and not the RSA population, and secondly, the audio-casette with the test stimuli has been recorded using the voice of an adult male speaker with a USA accent.

Although the language structures used in the Willeford Battery of Central Auditory Function should be familiar to the RSA population, there are a few words and phrases such as "gas", "dime" and "Fourth of July" that do not form part of South-African English. As the aim of the study was to assess the central auditory processing and compare the intergroup tendencies of each experimental group (and not the applicability of the norms of the Willeford Battery of Central Auditory Function to the RSA population) it was decided to use this battery of tests without any adaptations or changes to the test items but to familiarize the subjects with the unfamiliar words and phrases prior to the testing (by explaining the meaning of the words and phrases, and asking the subjects to repeat the words). A list of the words with which the subjects were familiarized is presented in Appendix D.

The test stimuli of the Willeford Battery of Central Auditory Function were retaped, using the voice of a speaker with a South African accent as the impact of the unfamiliar accent would have influenced not only a few but all the test items. Permission to retape the test stimuli was obtained from Professor J A Willeford (personal telephone conversation, 1989). An electrical engineer at the Department of Electrical and Electronical Engineering at the University of Pretoria built the filters and equipment required to retape the test stimuli (as stipulated in the test manual) and the test stimuli were recorded using the voice of an adult male speaker with a South-African accent similar to that of the subjects.

- **Audiometric equipment**

A GSI-10 Audiometer and Philips N2520 audio-cassette recorder were used for administering the Willeford Battery of Central Auditory Function to the subjects. The testing took place in a sound-proof booth and Telephonic TDH-50 earphones with MX41/AR cushions were used.

DATA COLLECTION PROCEDURES

The twenty subjects were individually assessed at the Department of Communication Pathology at the University of Pretoria. Each subject was exposed to a 2 hour 20 minute test procedure and the testing was completed in a single session. Subjects were, however, permitted to rest if they became fatigued, and all the subjects were given a break of 15 minutes and refreshments midway through the testing.

Puretone testing and immittance were administered using the instructions and procedures stipulated by ANSI

53.21 - 1978 (in Silman & Silverman, 1991) and the GSI-33 Middle Ear Analyzer test manual. Subjects were required to have normal hearing acuity and middle-ear functioning as a prerequisite to the administration of the CELF and the Willeford Battery of Central Auditory Function. The average time required to complete the puretone testing and immittance was 10 minutes per subject.

The subjects were then familiarized with the words listed in Appendixes B and D prior to the administration of the CELF and Willeford Battery of Central Auditory Function. The meaning of the words in these appendixes were explained and the subjects were asked to repeat the words. This process took approximately 10 minutes per subject.

The CELF was then administered in a quiet non-distractable room following the standardized instruction and administration procedures stipulated in the CELF Diagnostic Examiners manual. The average time required for the administration of the CELF was 1 hour 10 minutes per subject.

Finally, the Willeford Battery of Central Auditory Function was administered following the standardized instructions and procedures stipulated in the test manual. The average time that was required for the administration of this battery of tests was 50 minutes.

DATA ANALYSIS AND PROCESSING

The subtests and tests of the CELF and Willeford Battery of Central Auditory Function were totalled for each subject by adding the scores obtained for each item. This information was then analyzed by a statistician using an IBM 370 Computer and the Biomedical Computer Programme. The statistical procedures employed to achieve each sub-aim are presented in Table 2.

RESULTS AND DISCUSSION

This section is presented according to the formulated sub-aims and entails a description and comparison of the language and central auditory processing of research groups 1 and 2.

DESCRIPTION AND COMPARISON OF THE LANGUAGE PERFORMANCE OF RESEARCH GROUPS 1 AND 2

The first sub-aim (namely, to determine and compare the intergroup tendencies of the language of research groups 1 and 2) was realized by administering the CELF (Wiig & Semel, 1980) to the subjects in the two research groups. The *General linear models procedure* (Steyn, Smit & du Toit, 1989) was used to establish the arithmetic mean of each research group for each subtest of the CELF, and the *Signed-rank test* (with a 5% level of significance) was used to determine whether significant differences occurred between the language performance of research groups 1 and 2 (Steyn et al., 1989). These results are presented in Table 3.

The **language processing subtests** on which research group 1 exhibited significantly lower scores than that of research group 2 (at the 5% level of significance) were the *Word and sentence structure subtest* (which assesses the ability to process and interpret word and sentence structures), the *Linguistic concepts subtest* (which evaluates the ability to process and interpret oral directions which contain linguistic concepts requiring logical operations), the *Relationships and ambiguities subtest* (which assesses the ability to process and interpret logico-grammatical and ambiguous sentences) and the *Oral directions subtest* (which evaluates the ability to interpret, recall and execute oral commands of increasing length and complexity). These results thus support the research findings of Zinkus et al. (1978), Brandes and Ehinger (1981), and Eimas and Clarkson (1986) who reported that children with a history of otitis media have significantly poorer receptive language abilities and have difficulty understanding complex and/or lengthy language structures.

The **language processing subtests** on which no significant differences occurred (at the 5% level of signifi-

Table 2: The statistical procedures used to achieve each sub-aim

Sub-Aim	Statistical Procedures
1. To determine the level of language performance and compare the intergroup tendencies of the language performance of research groups 1 and 2	1.1 **The General linear models procedure** was used to establish the arithmetic mean of each research group for each subtest of the CELF (Steyn, Smit & du Toit, 1989) 1.2 **The Signed-rank test (with a 5% level of significance**) was used to determine whether significant differences occurred between the language performance of research groups 1 and 2 (Steyn et al., 1989)
2. To determine the level of central auditory processing and compare the intergroup tendencies of the central auditory processing of research groups 1 and 2	2.1 **The General linear models** procedure was used to establish the arithmetic mean of each research group for each test of the Willeford Battery of Central Auditory Function (Steyn et al., 1989) 2.2 **The Signed-rank test (with a 5% level of significance**) was used to determine whether significant differences occurred between the central auditory processing of research groups 1 and 2 (Steyn et al., 1989)

cance) in the performance of research groups 1 and 2 were the *Word classes subtest* (which evaluates the ability to perceive relationships between verbal concepts and identify word pairs) and the *Spoken paragraphs subtest* (which evaluates the ability to process and interpret salient information presented). The *Word classes subtest* consists of items featuring three or four verbal concepts of which two are associated. The child is required to identify the two concepts which are related. The subjects in both research groups 1 and 2 found this subtest less taxing than the other language processing subtests, and it is thus possible that the *Word classes subtest* is less sensitive than the other language processing subtests in identifying the language impair-ment associated with early recurrent otitis media in children. The *Spoken paragraphs subtest* consists of four paragraphs of increasing length and complexity and the child is required to recall details such as proper names, numerical and geographical data. The subjects in both research groups 1 and 2 performed poorly on this subtest and can possibly be attributed to the high incidence of unfamiliar words (that do not form part of South-African English, for example: candy, drugstore and dollar) which occur in this subtest. The subjects in both research groups had difficulty in recalling these words despite having been familiarized with these words prior to the testing. This finding highlights the need for language assessment procedures that have been compiled and standardized for the RSA population.

The language production subtests on which research group 1 exhibited significantly lower scores than that of research group 2 (at the 5% level of significance) were the *Confrontation naming subtest* (which evaluates the child's accurancy, fluency and speed in naming colours, forms, and colour-form combinations), the *Model sentences subtest* (which assesses productive control of sentence structures in a sentence repetition task) and the *Formulated sentence subtest* (which evaluates the ability to formulate and produce sentences). These results support the research findings of Jerger et al. (1983) and Menyuk (1986) who found that children with a history of otitis media produce fewer sentences with prepositional phrases, use a higher incidence of simple sentences and experience difficulties with

Table 3: A comparison of the language performance of research groups 1 and 2 on the Celf subtests (at the 5% level of significance)

The Celf Subtest			Average achievements or arithmetic means of research groups 1 and 2		Comparison of the language performance of research groups 1
			Research group 1	Research group 2	
I	1	Word and sentence structure	20	25	▒
	2	Word classes	10,7	11,3	
	3	Linguistic concepts	26	28,7	▒
	4	Relationships and ambiguities	9,9	19,7	▒
	5	Oral directions	11	15,6	▒
	6	Spoken paragraphs	1	1,1	
II	7	Confrontation naming: accuracy	29,1	32,7	▒
		Confrontation naming: time	161,8	130	▒
	8	Word associations	11	11	
	9	Model sentences	19	23	▒
	10	Formulated sentences	14	16	▒
III	11	Processing speech sounds	119,8	120	
	12	Producing speech sounds - blends	52	52	
		Producing speech sounds - final position	18	18	
		Producing speech sounds - initial position	20	20	

KEY:

I Language processing subtests
II Language production subtests
III Supplementary subtests
☐ No significant difference between research groups 1 and 2.
▒ Performance of research group 1 lower than experimental group 2.

syntax and morphological markers.

There was, however, no difference in the performance of research groups 1 and 2 for one of the **language production subtests**, namely the *Word associations subtest* (which evaluates the quantity and quality of the retrieval of semantically related word series from long term memory). This subtest requires the child to name as many members as possible from two semantic classes, foods and animals, in sixty seconds. The subjects in both research groups 1 and 2 found this subtest less taxing than the other language production subtests, and it is thus possible that the *Word associations subtest* is less sensitive than the other language production subtests in identifying the language impairment associated with early recurrent otitis media in children.

There were also no significant differences between the two research groups (at the 5% level of significance) for **the supplementary subtests of the CELF**, namely the *Processing of speech sounds subtest* (which evaluates the ability to discriminate between speech sounds in minimally different word pairs) and the *Producing speech sounds subtest* (which evaluates the child's accuracy in articulating blends, final position phonemes and initial position phonemes). These results support the research finds of Roberts et al. (1988) who found no significant correlations between early recurrent otitis media, auditory discrimination and articulation disorders in children.

DESCRIPTION AND COMPARISON OF THE CENTRAL AUDITORY PROCESSING OF RESEARCH GROUPS 1 AND 2

The second sub-aim (namely, to determine and compare the intergroup tendencies of the central auditory processing of research groups 1 and 2) was realized by administering the Willeford Battery of Central Auditory Function (Willeford, 1974) to the subjects in the two research groups. The *General linear models procedure* (Steyn et al., 1989) was used to establish the arithmetic mean of each research group for each test of the Willeford Battery of Central Auditory Function, and the *Signed-rank test* (with a 5% level of significance) was used to determine whether significant differences occurred in the central auditory processing of research groups 1 and 2 (Steyn et al., 1989). These results are presented in Table 4.

The results of the Willeford Battery of Central Auditory Function showed that the central auditory processing of subjects in research group 1 was significantly lower than that of research group 2 for both of the **cortical procedures**, namely the *Filtered speech test (test conditions: left and right ear)* and the *Competing sentence test* for the *weak ear condition*. These results support the research findings of Welsh et al. (1983) who reported that children with a history of otitis media exhibit lower scores than their disease-free peers on the cortical procedures of the Willeford Battery of Central Auditory Function.

There was, however, no significant difference between the two research groups for the *strong ear condition* of the *Competing sentence test*. This finding suggests that the maturation of the strong ear condition may be less susceptible to the negative influence of early recurrent otitis media. Further research is, however, necessary to substantiate this hypothesis as there is no evidence in the literature to support this finding. It is interesting to note that the strong ear was the right ear for all the subjects in research groups 1 and 2. As documented in Kaplan, Gladstone & Katz (1984), the strong ear is usually the right ear and scores in the weak ear continue to improve until the age of ten years when ear performance becomes equal for the competing sentence test.

Table 4: A comparison of the central auditory processing of research groups 1 and 2 (at the 5% level of significance)

The Willeford Battery of Tests			Average achievement or arithmetic means of each research group		Comparison of the central auditory processing of reserach groups 1 and 2
			Research group 1	Research group 2	
1	Competing sentence test	*Weak ear	30	67	
		*Strong ear	85	89	
2	Filtered speech test	Left ear	21	46	
		Right ear	20	51	
3	Binaural fusion test	Left ear	80	87	
		Right ear	81	88	
4	Rapidly alternating speach perception test	Left ear	75	90	
		Right ear	77	92	

KEY:

☐ No significant difference between research groups 1 and 2.

▒ Performance of experimental group 1 lower than research group 2.

* The weak ear was the left ear and the strong ear the right ear for all the subjects in research groups 1 and 2

The performance of research group 1 was also significantly lower than that of research group 2 for the first **brainstem procedure**, namely the *Rapidly alternating speech perception test* (test conditions : left and right ear performance) but no significant difference occurred for the second brainstem procedure, namely the *Binaural fusion test* (test conditions : left and right ear performance). These results contradict the research findings of Welsh et al. (1983) who reported that children with a history of otitis media exhibit lower scores than their disease-free peers on the Binaural fusion test but similar scores for the Rapidly alternating speech perception test. These contradictions can possibly be attributed to the fact that the subjects included in the study were familiarized with the words listed in Appendix D prior to the testing (as discussed in the Methodology). This procedure may have influenced the internal validity of the Binaural fusion test (where the child is asked to repeat words filtered in such a way that a low pass segment is presented to one ear and a high pass segment is simultaneously presented to the other ear) as it is easier to remember and repeat words with which one is familiar. The Rapidly alternating speech perception test consists of sentences which are presented in alternating bursts of 300 m. sec. duration to first the one ear and then the other. Although the subjects were familiarized with the unfamiliar words included in these sentences, they were not familiarized with the actual sentences which are more difficult to repeat than words (as required for the Binaural fusion test).

The above results thus provide evidence for associations between early recurrent otitis media and delayed central auditory processing abilities and support the research finds of the limited number of human studies (Folsom et al., 1983; Welsh et al., 1983; Finitzo et al., 1990; Hurley & Hurley, 1995) available.

To summarize, the results of the study found the language and central auditory processing abilities of children with early recurrent otitis media to be significantly poorer than that of their disease-free peers. This finding is concerning as the children included in the study were in grade one (and turning seven years old). Children with a history of early recurrent otitis media thus enter school at a disadvantage as impaired and/or delayed language and central auditory processing abilities place children at greater risk for developing scholastic difficulties (Friel-Patti, 1990). The language and central auditory processing impairments and/or delays associated with early recurrent otitis media should thus ideally be resolved before children enter school (Paden, 1994). Although the results do not shed much light on the hypothesis of a critical period, it would appear that early recurrent otitis media has a negative influence on the development of language and central auditory processing during the first six years of life. Further research is necessary to determine the barriers of the critical period and to determine whether children are able to overcome language and central auditory processing disorders once the upper limit of this period has been reached.

A criticism that can be directed at the study and other retrospective studies (Holm & Kunze, 1969; Zinkus et al., 1978; Collazo & Kricos, 1986) is the fact that parental recall and physician's records of children's histories of early recurrent otitis media are not always accurate (Paden, 1994). Based on the results of the study, it is felt that a prospective longitudinal study where the history of otitis media is carefully monitored and documented, and language and central auditory processing are assessed from birth to puberty would help to improve the speech-language pathologist and audiologist's understanding of the associations that exist between early recurrent otitis media, language and central auditory processing in children. Prospective research is, however, expensive and is thus not always practical or viable, particularly in a country such as the Republic of South Africa where the poor economic situation has resulted in drastic financial cutbacks in research programmes. It is hoped that the results of the study will help to stress the importance of further research in this area, and that a prospective study will be possible in the near future. In the interim, the results of the study stress the importance of vigorous prevention, identification and intervention programmes for children with a history of early recurrent otitis media.

CONCLUSION

The results of the study have shown that the language and central auditory processing of the children with a history of early recurrent otitis media (research group 1) were significantly poorer than for their disease-free peers (research group 2). Children with a history of early recurrent otitis media were thus found to enter school at a disadvantage as impaired and/or delayed language and central auditory processing abilities place children at greater risk for developing scholastic difficulties. The results of the study stress the importance of vigorous prevention, identification and intervention programmes for children with a history of early recurrent otitis media and the need for further research to improve the speech-language pathologist and audiologist's understanding of the relationships that exist between early recurrent otitis media, language and central auditory processing in children.

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Appendix A: Summarized overview of the subtest of the celf (Wiig & Semel, 1980)

	Subtest		Description of each subtest
I	1	Word and sentence structure	Assesses the child's ability to process and interpret selected word and sentence structures.
	2	Word classes	Evaluates the child's ability to perceive relationships between verbal concepts and identify word pairs.
	3	Linguistic concepts	Evaluates the ability to process and interpret oral directions which contain linguistic concepts requiring logical operations.
	4	Relationships and ambiguities	Evaluates the ability to process and interpret logico-grammatical and ambiguous sentences.
	5	Oral directions	Evaluates the ability to interpret, recall and execute oral commands of increasing length and complexity.
	6	Spoken paragraphs	Evaluates the ability to process and interpret spoken paragraphs and recall salient information presented.
II	7	Word series	Assesses the accuracy, fluency and speed in recalling and producing selected automatic-sequential word series.
	8	Confrontation naming	Evaluates the accuracy, fluency, and speed in naming colours, forms, and colour-form combinations in a sustained confrontation-naming task.
	9	Word associations	Evaluates the quantity and quality of the retrieval of semantically related word series from long term memory.
	10	Model sentences	Assesses productive control of sentence structure in a sentence repetition task.
	11	Formulated sentences	Evaluates the ability to formulate and produce sentences when word and sentence form choices are limited and when semantic and syntactic constraints are introduced by a word which has to be included.
III	12	Processing speech sounds	Evaluates the ability to discriminate between speech sounds (phonemes) in minimally different word pairs.
	13	Producing speech sounds	Evaluates the accuracy in articulating selected elicited speech sounds (phonemes).

KEY:

I Language processing subtests
II Language production subtests
III Supplementary subtests

Appendix B: The list of unfamiliar words with which subjects were familiarized prior to the administration of the Celf

	sneakers	football player	candy
	yards	mailman	dollar
	drugstore		

Appendix C: Summarized overview of the tests of the Willeford Battery of Central Auditory Function (Willeford, 1974)

	TEST	DESCRIPTION OF EACH TEST
I	Competing sentence test	The test stimuli consist of simultaneously presented competing sentences presented to opposite ears. Ten of the competing sentence pairs are presented with the primary sentence in the left ear and the other 10 competing sentence pairs are then presented with the primary sentence in the right ear. The child is asked to repeat the primary sentence in the test ear. Two percentage scores are then obtained, namely the weak ear score (test condition : weak ear) and the strong ear score (test condition : strong ear). The strong ear is usually (but not always) the right ear for young children. Scores in the weak ear improve until the age of 10 years when ear performance becomes equal.
	Filtered speech test	The test stimuli consist of low-pass filtered consonant-vowel-consonant words presented first to the left ear (test condition : left ear) and then to the right ear (test condition : right ear). The child is asked to repeat the words heard first in the left ear and then in the right ear. The difference between the left and right ear response is minimal, i.e. a balanced response is obtained.
II	Binaural fusion test	The test stimuli consist of spondee words filtered in such a way that a low pass segment is presented to one ear and a high pass segment is presented simultaneously to the other ear. The child is asked to repeat the words. The test ear is reported with reference to the ear receiving the low pass segment. The low pass segment is first presented in the left ear with the high pass segment to the right ear (test condition : left ear) for the first list of words. The low pass segment is then presented to the right ear with the high pass segment to the right ear (test condition : right ear) for the second list of words. The difference between the left and right ear response is minimal, i.e. a balanced response is obtained.
	Rapidly alternating speech perception test	The test stimuli consist of sentences which are presented in alternating bursts of 300m. sec. duration, first to one ear and then the other. The child is asked to repeat the sentences. The test ear is the ear in which the first burst starts, for example: starts in the left ear (test condition : left ear) or starts in right ear (test condition : right ear). The difference between the left and right ear response is minimal, i.e. a balanced response is obtained.

KEY:

I Cortical procedures
II Brainstem procedures

Appendix D: The list of unfamiliar words and phrases with which the subjects were familiarized prior to the administration of the Willeford Battery of Central Auditory Function

gas	bluejay	sweater
Fourth of July	bobwhite	fall
band-aid	bonbon	garbage man
baseball	buckwheat	hash
football	drugstore	whizzbang
rush hour traffic	soybean	watchword
dime		

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REFERENCES

References should be cited in the text by surname of the author and the date, e.g., Van Riper (1971). Where there are more than two authors, after the first occurrence, *et al.* after the first author will suffice, except for six or more when *et al.* may be used from the start. The names of all authors should appear in the Reference List, which should be listed in strict alphabetical order in triple spacing at the end of the article. All references should be included in the List, including secondary sources, (APA Pub. Man. 1983, p.13). Only acceptable abbreviations of journals may be used, (see DSH ABSTRACTS, October; or *The World List of Scientific Periodicals).* The number of references should not exceed much more than 30, unless specifically warranted.

EXAMPLES

Locke, J.L. (1983). Clinical psychology: The explanation and treatment of speech sound disorders. *J. Speech Hear. Disord., 48* 339-341.

Penrod, J.P. (1985). Speech discrimination testing. In J. Katz (Ed.), *Handbook of clinical audiology* (3rd ed.). Baltimore: Williams & Wilkins.

Davis, G.A. & Wilcox, M.J. (1985). *Adult aphasia rehabilitation: Applied pragmatics.* San Diego, CA: College-Hill.

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Acceptable manuscripts may be returned to the author for revision. Additional minor changes may also be made at this stage, but a note on the manuscript acknowledging each alteration made by the author, is required. The paper is then returned to the editorial committee for final editing for style, clarity and consistency.

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Manuskripte behoort deur 'n dekkingsbrief vergesel te word wat die skrywer se adres en telefoonnommers bevat. Daar word van alle bydraers verwag om die styl, soos gespesifiseer is in die *"Publication Manual of the American Psychological Assoc.* (3rd ed., 1983) (APA Pub. Man."), nougeset te volg met volledige interne ooreenstemming. Manuskripte moet getik, van hoë gehalte en in drievoud spasiëring met wye kantlyne wees. **Vier** kopieë van die manuskrip moet verskaf word. **EEN** hiervan moet 'n identiese skyfkopie van die artikel wees. Lêername behoort die eerste skrywer se voorletters en 'n duidelike identifiseerbare sleutelwoord of afkorting daarvan in te sluit en moet op die laaste lyn van die bladsy van die verwsyingslys getik word (slegs vir naslaan doeleindes).

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Verwysings in die teks moet voorsien word van die skrywer se van en die datum, b.v., Van Riper (1971). Wanneer daar egter meer as twee skrywers is, moet daar na die eerste verskaffing van al die outeurs, van *et al.* gebruik gemaak word. In die geval waar daar egter ses of meer outeurs ter sprake is moet *et al.* van die begin af gebruik word. Al die name van die skrywers moet in die Verwysingslys verskyn wat aan die einde van die artikel voorkom. Verwysings moet alfabeties in trippel spasiëring gerangskik word. Al die verwysings moet in die Verwysingslys verskyn, insluitende sekondêre bronne, ("APA Pub. Man." 1983, p.13). Slegs aanvaarbare afkortings van tydskrifte se titels mag gebruik word, (sien "DSH ABSTRACTS, October"; of *The World List of Scientific Periodicals).* Die aantal verwysings moet nie meer as 30 oorskry nie, tensy dit geregverdig is.

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Locke, J.L. (1983). Clinical psychology: The explanation and treatment of speech sound disorders. *J. Speech Hear. Disord., 48,* 339-341.

Penrod, J.P. (1985). Speech discrimination testing. In J. Katz (Ed.), *Handbook of clinical audiology* (3rd ed.). Baltimore: Williams & Wilkins.

Davis, G.A. & Wilcox, M.J. (1985). *Adult aphasia rehabilitation: Applied pragmatics.* San Diego, CA.: College-Hill.

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