THE EFFECT OF
OTITIS MEDIA WITH EFFUSION (OME)
ON EMERGING LITERACY

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ABSTRACT

Otitis Media with Effusion (OME), commonly referred to as glue ear, is one of the most common illnesses of early childhood. It is difficult to detect as OME is frequently symptom free and usually clears spontaneously. It can be detected by tympanometry, a simple painless non intrusive test, which can be easily performed by trained operators. In New Zealand all children have this hearing test on school entry. Research has shown links between OME and educational under achievement, possibly due to the intermittent deafness which accompanies this condition. As OME mostly occurs during early childhood, a time when the basis of language is being established, it may cause delays in learning which will not be seen until later in life.

This research was designed to examine the possible effect of OME on emerging literacy in 120 children from a large urban area of New Zealand. The aural history of the children was established from a questionnaire and the results of the hearing tests on school entry. Measures of their reading ability were obtained from their scores on the Diagnostic Reading Survey. This survey, usually referred to as the six year old net test, is taken by most children in New Zealand. The childrens' scores on the reading test were examined to see if there was any correlation between these and evidence of OME.

Although no conclusive proof was found that children with OME were reading at a lower age than their peers, statistically significant differences were found between the scores of the Dictation section of the test. The Dictation section is designed to measure how well children are distinguishing and recording individual sounds in words. The findings suggest that OME affects auditory discrimination so that incorrect symbols are ascribed to sounds. This effect will hinder a child when learning to read and may cause delays in other aspects of learning.

No evidence of increased incidence of OME amongst Maori or Pacific Island students was found, however, the number of these students in the sample was very small. Maori and Pacific Island students however did have significantly lower scores than their peers in all aspects of the reading test.

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My interest in glue ear and its effects on academic achievement began after reading a paper by Dr Peter Allen, a general practitioner from Whangarei who has developed expertise in this area. As well as instigating programmes for the early detection and treatment of glue ear he has produced books and a video to educate parents and health professionals. I wish to record my appreciation for the assistance and information he provided during the initial stages of this thesis.

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INTRODUCTION

Otitis media with effusion (OME) is one of the most common illnesses of early childhood. Based on studies done in New Zealand a conservative estimate is that one in four children have episodes of otitis media in any one year between birth and age five (Chalmers, Stewart, Silva and Mulvena 1989). This figure probably only reflects a small number of the actual children who suffer from this disease as in many cases the child is not taken to a doctor so the condition is not medically diagnosed. The onset of the disease is often insidious without any obvious symptoms thus it is difficult to detect and often remains untreated. A child with OME is often labelled as slow, disruptive or just plain naughty.

Studies in New Zealand suggest that the incidence of OME is high, particularly amongst Maori children, and may contribute to educational under achievement. In 1992 in New Zealand 9.6% of all school entrants failed sequential hearing tests, the rates for Maori and Pacific Island children being 15.6% and 14% respectively. Most of these failures are due to OME (Ministry of Health, 1994).

Overseas research has shown a possible link between OME and academic achievement however little research has been done in New Zealand. The Dunedin Multidisciplinary Study initially found that there appeared to be no lasting differences in comprehension and articulation between children with OME and their peers. Further research by this group has caused them to reverse the earlier findings. They now believe the difference in reading and articulation is significant and long lasting (Allen, 1992).

Whilst OME is not a life threatening condition there is a high degree of morbidity associated with both the infection and the accompanying hearing loss. It is the hearing loss that leads to the hypothesis that academic achievement will be adversely affected in children who have a history of OME. Hearing loss in early childhood can have a profound effect on the child's overall development, both social and educational. In the first few years of life the child is responding to language and laying down the structures for the reception and production of language.

Feagans and Proctor (1994) argue that children with even a mild hearing loss have difficulty in processing language due to their inability to hear sounds correctly. This difficulty in hearing and interpreting sounds may lead to later problems for the child when decoding the written word into meaningful language. Thus learning to read, which is based on accurate decoding of a written message, will present difficulties for such children.

Because of the social and financial implications for children experiencing difficulties in learning to read this present research was designed to examine whether there is a link between a history of OME and reading ability. If it was found that OME is a possible cause of later academic difficulties then remedial work could be started pre school or on school entry to help children at risk.

REVIEW OF THE LITERATURE ON THE LINKS BETWEEN LEARNING AND OTITIS MEDIA WITH EFFUSION (OME)

There have been conflicting findings from research on the possible effects of OME on academic achievement. Some researchers have found definite links between early onset, or persistent OME, whilst others have found little evidence to support this view.

The effects of OME on educational and behavioural development were investigated as part of the Dunedin Multidisciplinary Child Development Study, a longitudinal study of 1000 New Zealand children from birth. This is the most comprehensive study of human development ever undertaken. Silva, Stewart, Kirkland & Simpson (1985) found a significant relationship between the presence of bilateral OME and effects on development, education and behaviour. Children with bilateral OME were found at age five to be significantly impaired in verbal comprehension, speech articulation, motor development and intelligence. They were reported also to have behavioural problems and to be more dependent, restless and fidgety. By the age of seven they were still disadvantaged in verbal comprehension, verbal intelligence and general intelligence. However by age eight the only difference found was in speech articulation.

Initially Silva et al. (1985) suggested that there is a compensatory period during which children affected by bilateral OME will catch up with their peers. This study supported the earlier findings of Howie, Jensen, Flemming, Peeler & Meigs (1979), Hoffman-Lawless, Keith & Cotton (1981) and Needleman (1977). The results of Needleman, however, are questionable as there was a preponderance of males in the study and males of this age traditionally perform more poorly than females on articulation tests. In all three studies (Silva, et al., Howie et al. & Hoffman-Lawless et al.) the children received early and continued medical treatment of the problem. The findings suggested that early identification and adequate follow up treatment can mitigate some of the adverse effects of OME.

In a paper published in 1986 Silva, Chalmers & Stewart appeared to reverse the earlier premise and found there was an overall significant difference in language development from ages three to nine. Speech articulation and reading scores were depressed in the

OME group as compared to the control group. Chalmers et al. (1989) also found that ongoing study of these children revealed that there were still problems persisting at age 11. Later research by Silva (cited in Allen 1991) found that the problems persisted at age 15 in the children with bilateral OME even though they had been treated and had grommets in both ears. On average they were two years behind their peers in educational achievement. They also had two to three times the rate of learning problems and their reading level was two years below that expected for their age.

It appears that although children in the Dunedin study were identified at age three as having OME and subsequently were adequately and correctly treated, adverse effects had occurred before this age. These effects had led to long term learning difficulties. A large proportion of OME remains undetected, or is treated inappropriately, and children in this group will be at greater risk than if the condition had been recognised and properly treated. Quick and Mandell (1983) highlight the point that most of the development of speech takes place before the age of three years. This is the time when OME is most prevalent and thus language acquisition could be inhibited if OME occurs at this critical time.

Quick and Mandell (1983) support the view that there is a link between OME and learning disabilities. However, many of the sources they quote in evidence can be criticised in light of the comments in the paper by Reichman and Healey (1983). Quick and Mandell found that recurrent OME has a negative cumulative effect on language development. By the age of 4 years these children were 12.7 months behind their peer group in receptive language development. They suggested an interventionist programme that could be used with children at pre-school level to prevent or alleviate later school problems. Groothius, Sell, Wright, Thompson & Altemeir (1979) also found that OME affects speech and language especially if the hearing impairment remains undetected.

Zinkus, Gottlieb & Schapiro (1978) and Zinkus & Gottlieb (1980) found that children with severe OME scored considerably lower on measures of intelligence and language acquisition than those with mild OME. Like Silva et al. (1986) they also found that the problems caused in auditory processing may persist long after the intermittent deafness of the OME has been resolved.

Studies with learning disabled subjects found that a higher proportion of the group had a history of middle ear problems than was present in the control group. Masters & Marsh, 1978 (cited in McGee et Silva, 1982) found that 7 year old children with problem behaviour were twice as likely to have had OME at age five than the control group. Kaplan, Fleishman, Bender, Baum & Clark, (1973, cited in Reichman & Healey 1983) in a longitudinal study of Eskimo children, found that children who had experienced early episodes of OME had lower academic achievement and verbal intelligence scores than the control group. These results have been severely criticised however as suffering from flaws in design and procedures (Ventry 1980 cited in Reichman & Healey 1983).

In contrast, Bol (1987) found no significant differences between test and control groups on language performance. Bol's method overcame many of the criticised flaws in other work. The children were carefully selected to fulfil the criteria of otitis prone having the initial attack before the age of 24 months and suffering repeated attacks since then. The hearing of the children was tested at the time of the language testing so ensuring that their hearing at that time was within normal limits. Much of the previous could be criticised in that no auditory tests were done at the time of the educational testing so compromising the results as the subjects may have been tested at a time of a temporary auditory loss. Limitations however apply to the research by Bol in the selection of subjects from patients attending a private otology clinic who were all from the upper socio-economic bracket. It could be expected, therefore, that they would have received prompt and adequate medical care all their lives. In addition all subjects were Caucasian which is not a representative sample of the New Zealand population. No link either was drawn between the number or severity of the attacks and any observed impairment however slight.

Hamilton & Owrid (1974) studied the effect of mild hearing impairment caused by OME on the linguistic attainment of children from lower socio-economic groups and found a positive correlation between the level of impairment and verbal comprehension. In addition the children with mild conductive hearing loss, as occurs with OME, showed marked delays in reading.

A widely reported study by Holm and Kunze (1969 cited in Quick & Mandell 1983) showed significant differences in children with early onset OME in processing information that required either, the receipt of auditory information or, a spoken response. Reichman and Healey (1983), however, are very critical of the selection of subjects and the methodology used in this research.

Although there appears to be a large body of evidence in support of the deleterious effect of OME on development of language the question of whether this is so remains unresolved (Chalmers et al. 1989 p 23). This present study was designed to see if there is a link between a history of OME and learning. As learning is a very ambiguous term and covers a wide range of topics and abilities the present study was confined to examining the effect of OME on learning to read.

There is no doubt that children who suffer from OME experience a degree of hearing loss. The question remains whether this hearing loss affects the child's ability to hear sounds correctly and encode these in the correct way. If a child does not hear correctly at the time when language and vocabulary are being established the wrong code will be attributed to a sound. Impairment of hearing causes a loss in auditory discrimination between sounds and especially the beginning sounds of words may be affected. These disturbances in encoding will lead to later difficulties with reading as learning to read is primarily a process of decoding a written message in light of a child's experience and prior knowledge.

In New Zealand all children have their hearing tested at age five and at age six they are tested on their reading ability. It was decided to examine the results of these tests to see if there was a correlation between the presence of OME and low reading scores.

OME can be considered to be present if the students have grommets or have failed the tympanometry test at age five. Research however indicates that many children have repeated ear infections which remain undetected or are only treated later in life and that a history of repeated ear infections or other ear problems may indicate undiagnosed OME. Students who fit these characteristics will be assumed to be possible OME sufferers and their scores counted. Of particular interest in the reading test are the scores for reading accuracy, sight word recognition, vocabulary and dictation since these are the most likely to be affected by hearing difficulties.

The incidence of OME amongst Maori is reported to be higher, as evidenced by a higher failure rate of hearing tests on school entry, 15.6% compared to 9.6% for all school entrants. Pacific Island children also exhibit a higher failure rate of 14% (New Zealand Hearing Statistics 1993). In this study these groups were identified to examine whether there was any evidence of ethnicity affecting the incidence of OME.

HYPOTHESES

1. Children with diagnosed OME as evidenced by grommet insertion will:
    - be reading at a lower level than expected for their age when tested on the six year old reading tests.
    - have dictation and word vocabulary scores on the six year old reading tests which are lower than expected.

2. Children with a history of numerous ear infections during early childhood will:
    - be reading at a lower level than expected for their age when tested on the six year old reading tests.
    - have dictation and word vocabulary scores on the six year old reading tests which are lower than expected.

3. Children who fail tympanometry tests on school entry are also likely to have OME and therefore will:
    - be reading at a lower level than expected for their age when tested on the six year old reading tests.
    - have dictation and word vocabulary scores on the six year old reading tests which are lower than expected.

4. There will be more evidence of the effects of OME amongst Maori and Pacific Island children than amongst the sample population as a whole.

THE CONNECTION BETWEEN HEARING AND OME

A knowledge of the anatomy of the ear and the mechanism of hearing is necessary to understand what is otitis media and how it can affect hearing and subsequently learning.

THE ANATOMY OF THE EAR

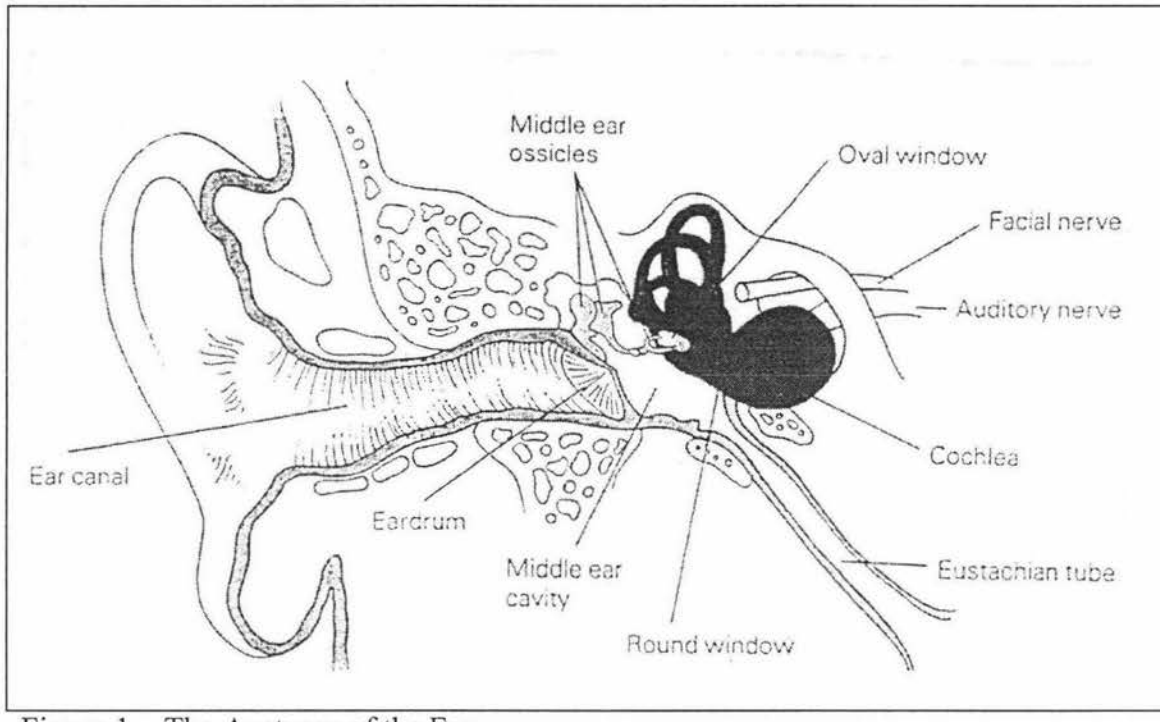

Figure 1 The Anatomy of the Ear

The ear consists of three sections the external, middle and inner ear. The outer or external ear consists of the ear canal which is separated from the middle ear by the ear drum or tympanic membrane.

The middle ear is filled with air and is connected to the nasopharynx by a small tube called the Eustachian tube. This tube allows air to enter the ear to keep the pressure equalised on both sides of the ear drum.

The inner ear consists of a fluid filled cochlea which connects with the middle ear by means of a delicate mechanism called the oval window. The cochlea is connected to the auditory or eighth cranial nerve which leads to the brain.

THE MECHANISM OF HEARING

When sound waves enter the outer ear they travel along the ear canal and "bump" against the ear drum causing it to move. These sound waves are actually changes in air pressure and cause the ear drum to vibrate. Thus the acoustical energy is transformed into mechanical energy. These vibrations stimulate the middle ear bones or ossicles (the malleus, incus and stapes) to carry the vibrations to the inner ear. The stapes which is the innermost bone is connected to the oval window. Movement of the window causes the fluid in the cochlea to move and the mechanical energy is now turned into hydraulic energy. This causes the minute auditory nerve endings in the cochlea, called hair cells, to be activated and produce electrical impulses. These hair cells join to form the eighth cranial nerve and transmit the electrical impulses to the brain for processing and interpretation.

Normal hearing depends on the middle ear being full of air. The oxygen and nitrogen in the air are absorbed from the middle ear so the air has to be constantly replaced. This is done via the eustachian tube which opens momentarily whenever we swallow allowing a small bubble of air to enter the middle ear and equalise the pressure on both sides of the ear drum.

WHAT IS OME?

Otitis media with effusion is a general term applied to any condition in which fluid is present behind the ear drum. Even if the fluid appears clear and the ear drum does not appear inflamed the fluid contains bacteria in up to 50% of the samples (Maw 1987). The term otitis media with effusion encompasses both acute and secretory otitis media. Secretory otitis media is commonly referred to as 'glue ear'. Throughout this text the term otitis media with effusion (OME) will refer to the secretory chronic condition unless stated otherwise.

In acute otitis media due to infection the middle ear rapidly fills with fluid leading to an increase in pressure in the ear which is extremely painful. It often occurs at night as the pressure in the ear drum increases in the supine position and air is no longer being swallowed through the blocked tube. The child usually wakes with intense pain and the area around the ear will be extremely painful to touch. There is frequently accompanying fever, malaise and hearing loss. An acute ear infection may not be caused by OME but the acute infection may be the first indication that the child has chronic OME. Therefore any child who suffers from recurring or repeated bouts of ear infection should be checked for underlying chronic OME.

Acute otitis media is rarely associated with any significant after effects and will regress spontaneously and clear within four weeks. In some cases, which are inadequately treated or not treated at all, the pus builds up until the ear drum bursts and the pus escapes and discharges from the ear which leads to cessation of the pain. This causes a small hole to be left in the ear drum which may close due to keratinisation and will be visible on examination of the ear drum as a thickening or scar tissue. This scarring causes the ear drum to be less flexible and therefore not so sensitive to changes in air pressure which may result in some degree of permanent hearing loss. In some cases there is a permanent perforation of the ear drum and there will be a persistent discharge from the ear. If infection is present this discharge will be discoloured and malodorous. If the condition remains undetected the hole may enlarge and cause erosion of the whole ear drum and permanent deafness results. If the condition persists over months or years the ear drum gradually retracts and drapes over the incus which leads to pressure on the middle ear bones causing erosion and resulting in permanent sensorineural deafness.

The normal ear drum is clear, thin and shiny like a piece of plastic film. In chronic otitis media the middle ear is intermittently filled with fluid over a long period and the ear drum becomes thick and golden brown in colour because of the fluid build up. This fluid is a thick brown mucous having the appearance and consistency of glue hence the common name for this condition `glue ear'. Chronic otitis media is slow and insidious in onset without any obvious signs of infection such as pain and fever therefore it tends to remain undetected. This collection of fluid does not allow the middle ear to transmit

sound as the ear drum can no longer vibrate in response to the sound waves. Hearing loss of between 20 and 40 decibels has been reported.

OME may be due to blockage of the eustachian tube which causes all the air in the middle ear to be absorbed. This creates a vacuum which leads to negative pressure in the middle ear which then fills up with fluid. It is not known why this occurs or where the fluid comes from. It may be a protective mucosal secretion from the cells lining the middle ear to stop the ear drum from collapsing or it may be due to bacteria. Lim (1979 cited in Maw 1987) suggests it is probably due to a combination of all these factors.

Blockage of the eustachian tube may be caused by anatomical abnormalities due to racial or genetic features. Eskimos and other indigenous Americans exhibit a higher incidence of OME than white Americans and Maw (1987) suggests this may be due to anatomical differences. However other factors such as socio-economic status, overcrowding, day care and maternal smoking have been identified as also causing an increased incidence of OME so it is simplistic to suggest that anatomical features alone cause an increase in the incidence of OME (Feagans & Proctor 1994).

Blockage can also occur as a result of some medical conditions such as sinus or nose infections or following viral infections of the upper respiratory tract (Maw 1987). There is a positive relationship between recent colds and the number of respiratory infections and OME (Visscher, Mandel, Batalden, Russ & Giebink 1985).

Most attacks of glue ear will spontaneously resolve without treatment over a period of two to three months however some 10% of children develop persistent glue ear which continues for years (Allen 1991). The condition can occur in one ear or in both ears. When in both ears it is referred to as bilateral otitis media. It is bilateral OME that is of the greatest concern as it appears from research by Silva et al. (1985) that it is this group whose learning and behaviour is most affected.

Treatment of the condition is with a 10 day course of antibiotics. If OME persists even after a two to three month course of antibiotics surgical intervention (myringotomy) is required. This involves making an incision in the ear drum and after removing the fluid a small plastic tube or grommet is inserted. A grommet is about the size of a match head and is shaped like a cotton reel with a small hole in the middle. The grommet acts as a ventilation tube and connects with the outside air allowing it to pass into the middle ear and equalise the pressure. Over a period of about a year a ring of keratin builds up around the tube and forces it out. If OME returns it is necessary to insert another tube.

What are the Signs and Symptoms of Otitis Media with Effusion?

- Frequent recurrence of, or persistent, ear infections.
- History of OME in the family, either siblings or parents. (Visscher et al. 1985, Kraemer, Richardson & Weiss 1983, Teele, Rosner & Klein 1980)
- Inappropriate responses to verbal requests or questions particularly if there is background noise such as occurs in a classroom.
- Inattentive or day dreaming behaviour, a seeming unawareness of what is going on around.
- Loud or aggressive behaviour may also be a sign as the child becomes frustrated with attempts at communication.
- There may be significant speech problems such as mispronunciation of word beginnings or endings.
- The child may not be doing very well at school.
- Presence of a flat tympanogram on audiological examination suggests OME.

THE INCIDENCE OF OME

The highest incidence of OME occurs in early childhood and decreases progressively after the age of six. The initial episode may be undetected because obvious symptoms are absent in up to 50% of cases that occur in early infancy. 50-60% of children with OME will experience the first attack before the age of one year and 70% before the age of three (Maw 1987). Figures by Stewart (1990), based on personal experience, state that 90% of New Zealand children will have experienced OME by their fifth birthday

with 70 % of children under the age of five suffering in any given year. These figures seem much higher than international figures which vary from 25% to 80% however there is variation in the method of reporting, and definition of, OME so accurate figures are difficult to establish (Chalmers et al. 1989). Although there appears to be a higher occurrence of bilateral OME in males (Stewart, Kirkland, Silva, Simpson & Williams 1985) this may be due to the larger number of childhood infections in males.

THE SITUATION IN NEW ZEALAND WITH REGARD TO OME

Hamilton, McKenzie-Pollock & Heath (1980) found that less than 25% of pre and primary school children had normal tympanic membranes. Children with damaged membranes showed poor educational achievement compared with their peers. Recent studies show that 10% of five year olds suffer from glue ear (G.P.Weekly 1992).

Although there are no national figures for the incidence of otitis media amongst the Maori population of New Zealand the statistics released by the National Audiology Centre in 1993 show that a higher percentage of Maori (15.6%) fail the hearing test on school entry than Europeans (9.4%). There is a general feeling amongst those working in the health field that OME occurs more frequently in Maoris than in Europeans (Whakarongo Mai 1989).

A survey in Waiapu by Moore (1978) found that OME was four times more common in Maori than in non Maori. Giles (1989) found that 25% of a group of Maori children had hearing loss. The leading case of hospitalisation for Maori children was for diseases of the ear or mastoid process and was three times higher than for non Maori (Whakarongo Mai 1989). The Maori population is a youthful one with 34% under the age of 15 as compared to 23% of non Maoris in this age group and this indicates that the problem of OME will increase (1986 census). As Pomare and deBoer (1988) state *'There is every indication that Maori educational under-achievement is due at least in part to conductive hearing loss, the consequence of untreated or poorly treated otitis media'.*

The differences in the incidence of OME amongst Maori may be due to genetic or anatomical differences. Wilkie (1991) states that Maori children have a shorter eustachian tube than Europeans and this may account for the prevalence of the condition amongst Maori children. However other factors such as family size, socio-economic status and environment have all been shown to affect the incidence of OME so it is not conclusive to base the incidence on ethnic differences alone (Feagans & Proctor 1994).

The Dunedin study (Chalmers et al. 1989) was the first definitive study in New Zealand to examine the possible links between OME and academic developmental difficulties. This study is still proceeding with the children being studied every two years and results indicate that the effects of OME persist long after the condition has resolved. The test and control groups in the Dunedin study were matched with regard to socio-economic grouping and maternal training. However Dunedin does tend to be slightly advantaged socio-economically and has a lower percentage of Maori than the rest of New Zealand so these findings should not be extrapolated to the country as a whole. Likewise in the research by Bol (1987) where no link was shown between OME and learning difficulties the sample was not representative of New Zealand. Thus the situation in New Zealand especially with regard to Maori children is probably worse than reported.

The Health and Education Ministries have recognised this problem with the launch of "Hearing is Sharing" which is aimed to raise the awareness of child hearing loss amongst professionals, parents and carers. Grants are now being made for general practitioners to purchase tympanometers in an attempt to identify OME as soon as possible so early intervention can occur. The Ministry of Health and Regional Health Authorities produced a consensus report to deal with the problems of persistent OME (Ministry of Health 1994). Research in Northland where a "grommet blitz" has been in place for some years now has shown that the number of children failing their hearing test on school entry has declined by 2.5% from 1992 to 1993 (NZ Hearing Screening Statistics 1993).

THE RELATIONSHIP BETWEEN HEARING AND SPEECH

THE NORMAL DEVELOPMENT OF SPEECH

A new born baby responds to loud sounds by being startled and giving a slight jump. The direction from which the sound comes, however, cannot be identified until the baby is about four months of age when particular sounds begin to be associated with certain persons or objects. Between the age of six and eight months the child begins to experiment with the sound of his/her own voice. This marks the beginning of "baby talk" sounds such as "da da da" and "ba ba ba" are repeated with pleasure and varying degrees of intensity and pitch. This is a result of normal physiological development but will only continue if the child can *hear* the sounds. At about one year of age the first word is uttered and gradually over the next six to twelve months other words are added so that by the age of two years the child has a vocabulary of about 24 to 30 words. It is over the next year that significant strides are made in vocabulary so that by the age of three the child has over three hundred words which they recognise and use. Between three and a half and five years the child learns to manipulate the words and true language is acquired. (Stell, Pracy & Siegler 1987). Thus the critical period for acquiring the basis of language is between about 18 months to five years of age. Any prolonged or intermittent disturbance of hearing during this time may lead to impairment in the child's speech and affect emerging literacy.

THE EFFECTS OF HEARING IMPAIRMENT ON DEVELOPING SPEECH

Hearing impairment is classified according to the degree of loss in terms of frequency (pitch) or intensity (loudness). Frequency is determined by the cycles per second (cps) or hertz (Hz). The average frequency range for normal hearing lies between 16 and 16,000 cps however the critical area for speech perception is between 250 and 4,000cps. Intensity of sound is expressed in decibels where decibel (dB) indicates the power of one sound relative to an arbitrary sound or reference point. Thus 0 dB does not indicate absence of sound but means a sound equal to the reference point. A sound of 60 dB is thus 60 dB higher than the reference point.

The point at which an individual responds to sound is called the hearing threshold (Cartwright, Cartwright & Ward 1989). In the case of impairment of hearing this threshold is raised so that the individual only responds to louder sounds than previously. In normal speech, fluctuations in overall amplitude provide clues to the structure of speech with vowels tending to be at a higher amplitude than consonants. This difference in amplitude can be as great as 40 dB (Miller 1951, cited in Summerfield 1987). The ear is able to discriminate between sounds of different intensity by means of a mechanism known as the auditory filter. In hearing impairment the auditory filter is wider than normal and thus selectivity is lost (Harpur 1987).

Important sounds are sometimes rendered inaudible by other sounds - this is known as masking. When this occurs the person becomes unable to discriminate between speech and background noise (Harrison, Aran & Erre 1981, Pick, Evans & Wilson 1977). The listener with impaired hearing may not be able to detect components of the weaker consonants so that ends of words such as *dark* and *tenth* are misheard and therefore pronounced incorrectly. These weaker consonants tend to be masked by preceding vowels (Summerfield 1987 p 919). In quiet conditions listeners with moderate hearing impairment will experience little difficulty in identifying the natural vowels i.e. between *beat* and *bit*. In a room with background noise however this ability falls by 75-80%. Blake and Busby (1994) surveyed 106 school classrooms and found that the acoustic conditions in the majority of these classrooms were unacceptable with Sound to Noise ratios of less than 12 decibels. The accepted level should be between 15 to 20 dB to ensure that noise will not interfere with speech recognition of the teacher's voice. The majority of classrooms are noisy places and will add to the learning difficulties of hearing impaired children.

THE EFFECT OF OME ON HEARING AND SPEECH

The most common sequelae of otitis media is hearing loss. Hearing loss with chronic OME is generally from 20 to 30 dB but can be as great as 50 dB (Paradise 1981). In OME the hearing loss may only be mild and fluctuating but even this has been found to have a significant adverse affect on the child's language and learning development (Zinkus et al. 1978, Holm & Kunze 1969, Skinner 1978). Five year old children with significant histories of OME had more difficulty than their peers in discriminating between voice changes signalling different voiced stop consonants. The intermittent hearing loss and as this is not always confined to one ear or the same ear means that the children receive inconsistent signals and thus find it difficult to process the phonetic information they are receiving (Clarkson, Eimas & Marean 1989). If the condition persists over a period of time especially in the critical years of early childhood, when the children are acquiring the basics of their parental language, there will be an increasingly deleterious effect on subsequent language skills and ultimately on academic achievement.

Persistent or chronic OME will cause a conductive hearing loss (Zinkus & Gottleib 1980, Zinkus et al. 1978, McLaughlin 1976 cited in Quick & Mandell 1983), however, in repeated infections damage to the inner ear can occur and this will result in a sensorineural loss which is even worse. Conductive hearing loss means that the auditory information received is neither constant nor accurate and the child will either not respond or will respond in an inappropriate way to sounds. Even a mild hearing impairment distorts sounds so the child is unable to differentiate between the nuances of speech or phonetic sounds. Thus there will be significant delays in receptive language ability and the speech will often be distorted and unclear. The child will have difficulty in communicating and this will lead to frustration which may manifest itself as aggressive or distracting behaviour.

THE EMERGENCE OF LITERACY

HOW DO CHILDREN LEARN TO READ?

Clay (1991 p 7) defines reading as "a message getting - problem solving activity which increases in power the more it is practised". Reading involves a continual questioning activity, testing meanings of words and sentences in order to make sense of the printed word. The foundations of literacy are laid down well before children start school. Clay (1991) suggests the more exposure children have to conversations with adults the greater the range of patterns and sounds they are exposed to and so they acquire rules of grammar and a range of vocabulary. The more contact young children have with books and writing in the pre school years the easier it is for them to learn to read. If they do not have this exposure due to poor environment or health related problems they will have difficulties in comprehending oral or written language. Thus when faced with a text in a story book they are unable to anticipate what might happen next.

Long before school entry children have learned to sufficiently discriminate between vocal sounds to differentiate one word from another. Children at first are unaware of the sounds within words, the most important aspect for them is the meaning; thus they are aware of words and sentences. It is only when they begin to learn to read that they start to think about sounds in words. They have to be taught to spot the component sounds in words in order to be able to read properly (Bradley 1988 cited Bryant and Bryant 1988). Auditory discrimination activities aim to have children perceive differences in non vocal sounds so that they are able to recognise words that begin with the same consonant. If health related problems have caused poor auditory discrimination these children will have particular difficulty in breaking language into its parts when learning to read.

In order to recognise words in print it is necessary to know how they sound so that a connection can be made between the spoken and written word. The reader's awareness of how sounds are represented in the written form is called phonological awareness (Clay 1991 p15). This is an ability to recognise the way that sounds are represented in

clusters of letters. This is not the same as an awareness of syllables. Syllables are the "smallest independently articulable segments of speech" (Wagner & Torrgesen 1987 quoted Tunmer & Rohl 1991). It is possible to break speech into syllables but not into phonemes because phonemes cannot be pronounced in isolation.

Explorations of the way in which children learn to read are placing increasing emphasis on phonological awareness. Authorities differ as to whether this awareness develops in oral language before literacy emerges or occurs in the early attempts of learning to read (Tunmer and Rohl 1991). Morais (1979 cited in Bryant & Bryant 1988) carried out research in Portugal using groups of illiterate and literate adults and concluded that awareness of sounds in words is a consequence of learning to read and not the other way about. Awareness of phonemes alone is not sufficient, the child has to learn that arranging these into a different order will produce a different word. In addition the child has to learn blending of sounds to be able to produce new words and to recognise these blends in print. Children may develop phonological awareness of sounds in activities which occur long before they learn to read. Activities such as playing with rhymes, singing games and action songs encourage children to perceive similarities and differences in word sounds. Children with an apparent insensitivity to the sounds in words often have difficulties with rhymes and rhythms.

Learning words in isolation, however, does not make a good reader. The child uses cues from past experience and the context in which the word occurs to "guess" at the word (Bradley cited in Bryant & Bryant 1988). Other readers read a word by its constituent shape or group of letters. In both these cases listening to the sound within the word or breaking it into its constituent parts plays very little part in the reading process. Debate also concerns whether "phonological awareness involves the ear in segmenting speech, the eye in segmenting print or the brain in learning about the inter relationship about the two" (Clay 1991).

An accomplished reader no longer looks at individual words or sounds they begin to "chunk" or clump these together to make new sounds. This is more efficient than looking at individual words and is a characteristic of all learning in that, with practice,

certain steps become automatic and the operator is unaware of them. With practice the child learns to scan the print, to read ahead, to make sense of the whole piece of text rather than reading it word by word. Thus fluent readers will often substitute a word when reading at speed. If however the word is wrong for the sense of the passage this will be self corrected on closer inspection of the word.

Readers become more efficient the more they read and the easier it becomes. Poor readers on the other hand do not get as much practice and therefore in the normal classroom situation will fall further and further behind. This is why it is essential that readers at risk are identified as soon as possible so they can be given individual attention and reading becomes automatic and enjoyable. The six year old diagnostic test is designed to identify children with problems so that remedial help can be given before it is too late. Otherwise the child may remain a poor reader, falling behind not only in reading but in other areas of achievement as well.

THE POSSIBLE EFFECTS OF OME ON EMERGING LITERACY

Clay (1991) believes that an essential part of recording speech in print by young children is recognising how sounds are recorded by letters. If even intermittent hearing loss occurs in the early years the child may not have acquired the ability to recognise word sounds or hear them correctly. The more a child talks with adults the greater the vocabulary and flexibility that is developed. The child learns to articulate sounds and copy those of the adult. If hearing impairment is present there may be limitations in the control of grammar and speech patterns and this will lead to difficulties in comprehending oral and written language. Although this difficulty may not be obvious, when learning to read there will be difficulty in breaking up language into its parts or in separating sounds into whole words (Clay 1991 p 38). Mild degrees of hearing loss particularly between the ages of two and four will severely limit the oral language and experience that the child brings to bear when learning to read.

Tremain (1987, cited in Tunmer & Rohl 1991) found that children who are learning to read will segment a syllable into *onset* and *rime* where onset is the initial consonant or group of consonants and rime is the obligatory vowel and any following consonants. She found that children first focus on the vowel portion of the syllable. If hearing impairment is present the vowel sound has the greater intensity and would mask the preceding *onset.* This results in the child mishearing words and being unable to recognise them when they see them in print. Tremain and Baron (1981, cited in Tunmer & Rohl 1991) also found that children are more aware of fricative consonants *f,v or z* than stop consonants such as *t,d or b.* This is possibly due to the different intensity of sound produced by these letters. An example of the effect that OME may have on speech is seen in the following example of Natalie aged 3 years and 4 months. The speech therapist said the word and Natalie repeated it (Allen 1991).

rat - wat	clown - hown
sit - sit	flag - fad
leg - ed	sweep - weep
zebra - efra	ski - dee
fish - fis	steps - teps
sheep - seep	bread - wed
chair - air	frog- frod
jam - zam	presents - prezent

Note that in each case Natalie identified and copied the vowel sound correctly but had difficulty with the beginnings and endings of the word. It is easy to see how this would cause difficulties when Natalie began learning to read as she has incorrect sounds associated with letter groups. With even a mild hearing impairment the child is unable to differentiate between the phonetic sounds and this will cause delays in learning to read.

METHOD

SAMPLE SELECTION

Schools

The sample of students for this project was selected from the six to seven year old age group in one urban area of New Zealand. As it was necessary to have students from all socio-economic groups, private schools were excluded from the sample selection. Nine state schools were invited to participate in the project and data was finally included from eight of these.

Subjects

Schools were asked to identify and list students who fitted the following criteria:

- a birth date between 1 September 1987 and 31 May 1988,
- six year old diagnostic survey reading test results were available,
- still at the school so that the permission of parents could be obtained to access the childrens' records.

The sample group excluded students born in the second term of the school year. This is a time when many school children suffer from colds which can affect the ear function tests. A child with a cold at the time of the test may record a fail and this false negative could affect the validity of the results.

195 permission slips were provided to the schools for distribution to the parents of students who met the criteria and 133 were returned, a response rate of 68.2%. The Privacy Act 1993 makes it impossible to identify the characteristics of the non return group in order to analyse the effect of the response rate on the results of the project.

Hearing test results at age 5 were obtained for 133 students from the school record cards.

Twelve students whose parents had not completed the questionnaire or whose answers were ambiguous were later excluded from the sample as was one child who was profoundly deaf and had hearing aids fitted in both ears.

The final sample of 120 students comprises 68 girls and 52 boys. The sample includes students from several ethnic backgrounds.

Table 1 Sample Population identified by Ethnic Group and Sex

Ethnicity	No	Percent	Girls	Percent	Boys	Percent
European	95	79.2	54	45.0	41	34.2
Maori	7	5.8	3	2.5	4	3.3
Pacific Islander	6	5.0	4	3.3	2	1.7
Asian	6	5.0	3	2.5	3	2.5
Maori/Pacific Islander	2	1.7	2	1.7	0	0.0
European/Maori	3	2.5	1	0.8	2	1.7
European/Pacific Islander	1	0.8	1	0.8	0	0.0
Total	120	100	68	56.5	52	43.5

Table 2 Total Urban Population under study identified by Ethnic Group and Sex

Ethnicity	No	Percent	Girls	Percent	Boys	Percent
European	741	71.9	348	33.8	393	38.1
Maori	211	20.5	96	9.3	115	11.2
Pacific Islander	79	7.7	45	4.4	34	3.3
Total	1031	100.0	489	47.4	542	52.6

(Source Ministry of Education 1994)

Comparing the sample (Table 1) with the total population (Table 2);

- the sample group equalled 11.6% of the available population,
- girls are over represented (56.5 % cf. 47.4%).

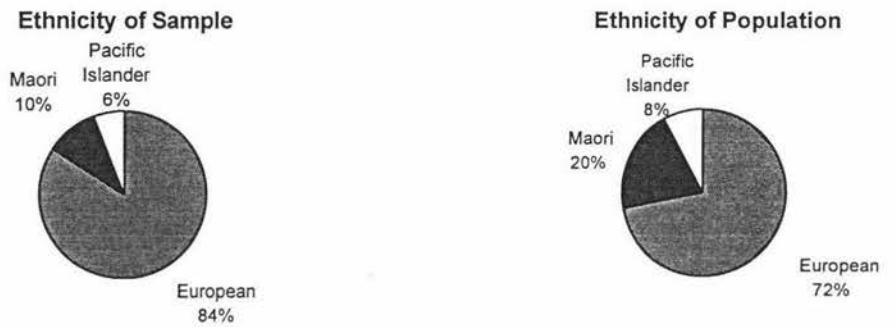

Figure 2 Comparison of Ethnicity of Population and Sample

Note

- For the purposes of these comparisons Asians in the sample population are grouped with European, and Maori/European and Maori/Pacific Islander are grouped with Maori.
- The figures in Table 2 are for all the six year olds in the urban area. The sample group was drawn from those children whose birthdays fell between September 1 and May 31 therefore the numbers in the urban population meeting the criteria for this research would be less than the numbers in Table 2. In order to calculate what percentage of the total population was included in the sample it is necessary to adjust the figures. Assuming that children are born approximately equally throughout the year the population figure becomes 773. The sample group therefore equalled 15.5% of the adjusted population.

PROCEDURE

As the information on the students ear function tests was to be obtained from the Public Health Service it was necessary to apply under the Health Information Privacy Code 1994 for permission to access these results. This required permission from the parents, the Public Health Service and approval from the Regional Health Authority Ethics Committee. Application was therefore made to both Massey University and the Regional Health Authority Ethics Committees for the research to proceed. When this was granted the following procedure was followed.

The schools were contacted by telephone and invited to participate in the project. A letter giving more details of the project and a copy of the research proposal was then sent to the principal. The questionnaire, consent form and letter to the parents were also included. (See Appendix One for copies of these forms) The questionnaire asked the parents to provide details of any ear problems which their child may have had.

After consultation with the Board of Trustees, the principal gave permission for the research to proceed. On the advice of staff involved, the wording of the consent forms and questionnaire was slightly modified for use in particular schools.

As the Privacy Act 1993 does not allow names and addresses of students to be released without permission of the parents, the school was asked to provide the number of students who met the stated criteria for inclusion in the project. The correct number of envelopes each containing the letter, consent form and questionnaire were then provided to the school. These were then addressed and distributed by the school who also arranged collection of the forms. The school issued reminders to the parents who had not returned the forms by the due date.

After the forms and questionnaires were returned to the school they were collected by the researcher. The school was visited and data collected on those students whose parents had given permission. The ethnicity, sex and ear function tests were obtained

from the individual student record cards and the results of the six year old reading test from school records.

Permission was granted from the Public Health Service to access the results of the students 3 year old tympanometry tests. However when they were given the list of students whose parents had given permission for the results to be obtained it appeared these results were not available.

INSTRUMENTATION

Hearing

Traditionally the only hearing test used was audiometry which registers whether a person has normal hearing or a degree of hearing loss. Since it has been recognised that OME is a possible cause of hearing loss, tympanometry is now performed as well.

Audiometry is usually difficult to carry out and is unreliable in children less than four years of age. Tympanometry requires skill and there is margin of user and technical error. In the schools in this sample all tests were done by skilled operators and in many cases the same person performed the test at ages three and five.

Testing on school entry has long been established in New Zealand but it is only in the last few years that testing has been introduced at age three. The only children tested at age three are those in a pre school situation, thus children who remain at home are not tested.

It is now the practice to perform tympanometry testing at age three and on school entry and audiometry testing on school entry. These tests are carried out by Hearing and Vision Testers employed by the Public Health Service. Under special conditions students who fail either test on the first occasion may be referred to their general practitioner but generally two consecutive failures are needed before a referral is made. In most areas visits are made to the school once a term which means that students failing should be retested in about 16 weeks time (NZ Hearing Screening Statistics 1993).

1. Audiometry

The level of hearing in each ear is tested separately by the use of ear phones. Sound is transmitted at one frequency with the level being gradually raised until the subject presses a button at the point when the sound is first heard. Readings are obtained over a range of frequencies by altering the frequency at which the sound is transmitted. This determines if there is a degree of hearing loss and over which range of frequencies it occurs. The point at which sounds are heard is referred to as the hearing threshold, this can be raised in OME so that a hearing loss of between 20 and 40 dB is common. Hearing can fluctuate from week to week and this is why this test alone is not an indicator of OME. An audiogram in a sound proof room does not give a true indication of the amount of noise distortion which occurs in a noisy environment such as a classroom.

Frequency(cps)	250	500	1K	2K	3K	4K	
Sound level(dB)							
10	x	x	x	x	x	x	*x = Left Ear*
20		0	0	0	0		
30	0					0	*0 = Right Ear*
40							
50							
60							

Figure 3 An Example of an Audiogram

In this case the subject shows a raised hearing threshold of between 20 and 30 dB in the right ear indicating a degree of hearing loss which requires further investigation.

2. Tympanometry

This is performed using an impedance meter which produces sound at constant rate in the ear and measures the amount of sound returning from the ear drum. In a normal ear the drum vibrates freely and total sound will be returned. The instrument also creates a range of positive and negative pressure and thus a tympanogram, the record obtained from this procedure, shows an inverted U peaking at zero pressure (Tympanogram A).

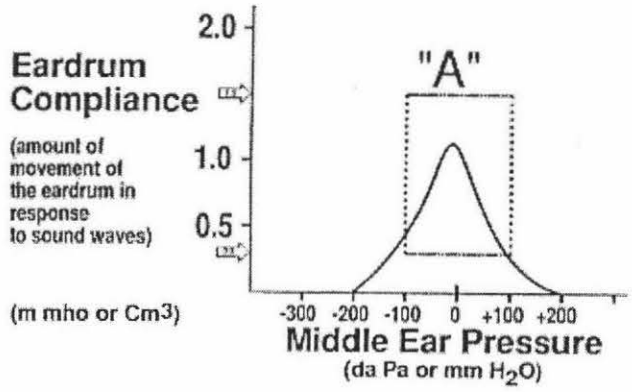

Figure 4 Tympanogram of Normal Ear

In OME there is fluid in the middle ear and the drum cannot vibrate so there is an absence of returning sound which results in a flat tympanogram (Tympanogram B).

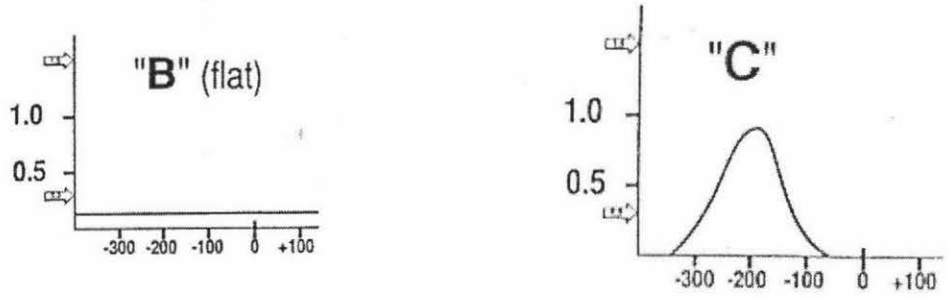

Figure 5 Tympanograms of Abnormal Ears

In cases when the middle ear is partly full of fluid and partly full of air the tympanogram has no discernible peak and gives a reading with negative pressure. This represents the stage before the middle ear is full of fluid (Tympanogram C).

Reading Test

Results from the Diagnostic Reading Survey (Clay 1993) were obtained from the school records. This is commonly referred to as the six year old NET test and is used in schools throughout New Zealand about the time of a student's sixth birthday. This test consists of a series of observations of the reading abilities of a student. There are six parts to the test and Clay requires all should be performed and no part should be used in isolation. The aim of the test is to identify an individual student's strengths and weaknesses in the areas of reading and writing. The test is standardised and administered in a set way to negate individual observer bias. In most schools it is carried out by the Reading Recovery teacher but in others it is performed by the classroom teacher. (See Appendix 3 for copies of the record sheets used) The scores for each part of the survey are converted into Stanine scores and then compared with standard Stanine scores. Stanines distribute scores according to the normal curve in nine groups from 1 (a low score) to 9 (a high score) with Stanine 5 being the norm. Stanine scores allow students to be compared one with another and against the national or school set of Stanine scores. (See Appendix 2 for National Stanine Scores)

1. Running Record

The first part of the survey is a measurement of the student's reading level. Books in the "Ready to Read" series are graded according to the level of difficulty of the text. There are 26 levels in the reading scale corresponding to approximate reading ages of five to eight and a half. (See Appendix 4 for a copy of this scale) The student first reads a previously seen text at the student's reported instructional level to give confidence and negate test nerves. Another text at the same level, but not previously seen by the student, is then read. If this is read with ease and 100% accuracy then a book at the next level of difficulty is chosen until the child meets with difficulties. A score is kept of the correct words read, the manner in which the student attempts the task and the number of self corrections noted. From these observations a score is calculated of the percentage of accuracy for the student. Reading a text with 94% accuracy is taken as the instructional level for the student.

2. Letter Identification

This measures the ability of the student to recognise individual letters from a list of 54 upper and lower case letters. As more and more letters are mastered by students this encourages them to become familiar with association of alphabetical names and their sound equivalents which increases their ability to choose alternatives when mastering reading.

3. Concepts about Print (CAP)

The CAP booklets "Sand" and "Stones" test how much information a student has gathered about the way language is written and books are printed. Observations are made of the student's behaviour as to whether the student can identify the front of the book from the back, text from pictures, letters from words and how she/he begins reading a text. These behaviours are pre-requisites for learning to read.

4. Word Test

The student is then given one of three lists of words to read. The set list contains the most frequently occurring words in the "Ready to Read" reading texts. The purpose of the test is to indicate the extent to which a student is compiling a reading or sight vocabulary. (See Appendix 5 for Word List)

5. Word Vocabulary

The student is then asked to write, from memory, all the words that can be remembered. Each completed word scores a point if it is correctly spelt. This is to observe the extent of hand eye co-ordination and the level of understanding the student has about print, i.e. that individual letters join to make words and again is a measure of sight and writing vocabulary.

6. Dictation

The last part of the observation consists of a dictated text of 37 words with the student writing the words as he/she hears them. This test distinguishes the availability to hear individual sounds (phonemes) and represent these by letters (graphemes). (See Appendix 5 for examples of text used)

The scores for each part of the test are recorded and then using tables, provided with the survey information, are converted to Stanine scores. These are then compared to the standard Stanine scores of the Diagnostic Reading Survey. In this way the student scores can be compared to see whether the student is in the "normal" range or is above or below the national averages. Children in the bottom 20% in each school are identified for inclusion in the Reading Recovery Programme which is a programme designed to accelerate reading performance to average level.

Questionnaire

The questionnaire distributed for completion by the parent or caregiver of each student was designed to obtain the aural history of each student. Students who had grommets fitted, and who thus had been diagnosed as having OME, were identified. In addition questions were asked about the number of ear infections, the ages when the first and last infections occurred, and whether or not relatives had a history of OME or ear infections. This information was used to identify students with a high number of ear infections who had not been treated with grommets. (See Appendix 1 for copy of questionnaire)

RESULTS

Table 3 Results of Hearing Test at Age Five

	Sample		Maori		Pacific Islander	
Result	No	Percent	No	Percent	No	Percent
Pass	96	80.0	7	58.3	7	100.0
Retest Once	16	13.3	5	41.6	0	0.0
Retest Twice	2	1.7	0	0.0	0	0.0
Fail	6	5.0	0	0.0	0	0.0
Total	120	100.0	12	100.0	7	100.0

Table 4 Results of Tympanometry Test at Age Five

	Sample		Maori		Pacific Islander	
Result	No	Percent	No	Percent	No	Percent
Pass	92	76.7	11	91.7	7	100.0
Retest Once	17	14.2	1	8.3	0	0.0
Retest Twice	2	1.7	0	0.0	0	0.0
Fail	9	7.5	0	0.0	0	0.0
Total	120	100.0	52	100.0	7	100

Tables 3 & 4 summarise the data obtained on the audiometry and tympanometry hearing tests. After initial screening at age five plus two repeat tests, six students (three boys and three girls) failed the audiometry test and nine students (five boys and four girls) the tympanometry test. No Maori or Pacific Island students failed either test.

The data was sorted into two groups for purposes of analysis i.e. Pass/Fail. The fail group included those who had one or two re-tests since hearing loss detected on one or two occasions has the potential to interfere with literacy learning. The tests are repeated at approximately 16 week intervals so the hearing loss may have extended over a whole school year.

EAR INFECTIONS

Number of Infections

Of the students in the sample 77 (57%) had suffered ear infections. Those with ten or less infections were grouped as low infection whilst those with more than ten were rated as high infection. There were 59 (76.6%) students in the low infection category and 18 (23.4%) in the high infection. Sixteen students were reported as having 15 or more infections including one who had about one a week since the age of three months. Seven of the group with grommets fell in the high category whilst two others had ten infections and one had only two. Eleven children with more than ten infections did not have grommets.

Using a paired *t* test it was found that there was a significant difference between the number of infections and failure on both hearing tests with a greater incidence of ear infections in the fail group ($F=12.32$, Prob. <0.01).

There were an equal number of boys and girls (9) in the high infection group, and 39 boys and 20 girls in the low infection group. This supports the findings of Stewart et al. (1985) who found that more males than females suffered from OME.

Age of Onset of Infections

The age of onset of ear infections ranged from one to 72 months with 39 (50.6%) having the first infection before the age of 24 months. A further 21 (27.3%) suffered the first attack before the age of 36 months. Bol (1987) defined children as being otitis prone if they suffered their first attack before the age of 24 months. The remaining students had their first infection between 42 and 72 months of age. Most students in the sample had few infections after the age of six years.

The age of onset of ear infections was compared to the number of infections.

- In the high infection group (n=18) 15 (83.3%) had the first infection at, or before, the age of 36 months.
- In the low infection group (n=59) 44 (74.6%) had the first infection at or before the age of 36 months

Age of Last Infection

- 24 (40.7%) students in the low infection group and 14 (77.8%) in the high group were reported as still suffering ear infections at age six.
- 15 (23.7%) students in the low group and 1 (5.6%) in the high group stopped ear infections at age 5 to 6
- 9 (15.2%) students in the low group and 2 (11.1%) in the high group stopped ear infections at age 4 to 5

The remaining students (12) suffered only one or two infections and these were before the age of 2 years.

Allen (1992) reports that the incidence of OME declines with age and most children will outgrow the condition by age of six or seven. The results show that about 60% of the low infection group but only about 22% of the high infection group had ceased infections before the age of six.

Family History

Table 5 Members of Students' Families with History of Ear Infections

Relation	No of Children	Percentage
None	58	48.2
Sisters	13	10.8
Brothers	18	15.0
Parent	9	7.5
Parent & Sister	3	2.5
Parent & Brother	5	4.2
Other	8	6.7
Brother & Other	2	1.7
Sister & Other	2	1.7
Multiple	2	1.7
Total	120	100.0

There appears to be a genetic influence on the incidence of OME (Vischer et al. 1985, Teele et al. 1980). Although not all cases of ear infections are attributable to OME it is interesting that the above results show that 51.8% of the group had family members with a history of ear infections. Only five of the ten students with grommets had other members of the family with a history of ear infections. In the group of students with ear infections 55 of the 77 had family members or close relatives with a history of ear infections.

OME is more prevalent in boys than girls (Stewart et al 1985) and these results show that there is a greater incidence of ear infections in brothers than in sisters i.e. 20.8% compared to 15.0%. As indicated previously there is also a greater number of infections in boys than girls.

DIAGNOSTIC READING SURVEY

For the purposes of this research the results from the identification of letters and concepts about print parts of the diagnostic reading survey were omitted. It was found that all the children had high scores on letter identification which indicated this had been well taught either in the first year of school or pre school. Concepts about print are unlikely to be affected by hearing impairment and are more likely to be a result of the extent of exposure to books which the students had experienced.

Reading Levels

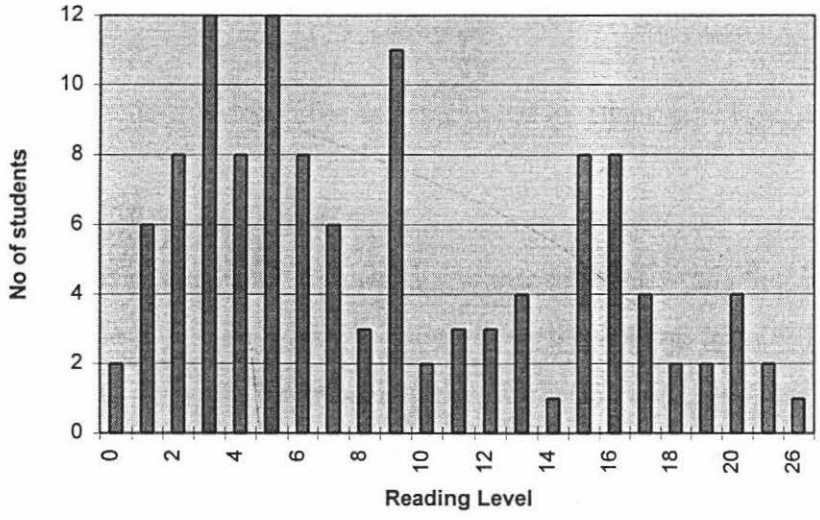

Figure 6 Reading Levels as determined by Diagnostic Reading Survey (n=120)

Figure 6 shows the reading levels of the sample. There is not the same degree of difficulty between each level on the scale. At the lower levels the difference between levels is less than at the higher levels. A student moves fairly rapidly through levels 1 to 9 then progress tends to slow as the text becomes more difficult (Glynn et al. 1989, cited in Iversen & Tunmer 1994 p 1). The mean reading level for the sample was 9.0 (SD 5.999) which is at the lower end of the expected reading levels of between 9 to 15. In fact only 10.8%(13) of the sample were reading at these levels with 63.3% (76) of the students being level 9 and below and 25.8% (31) above level 14.

Sight Word Score

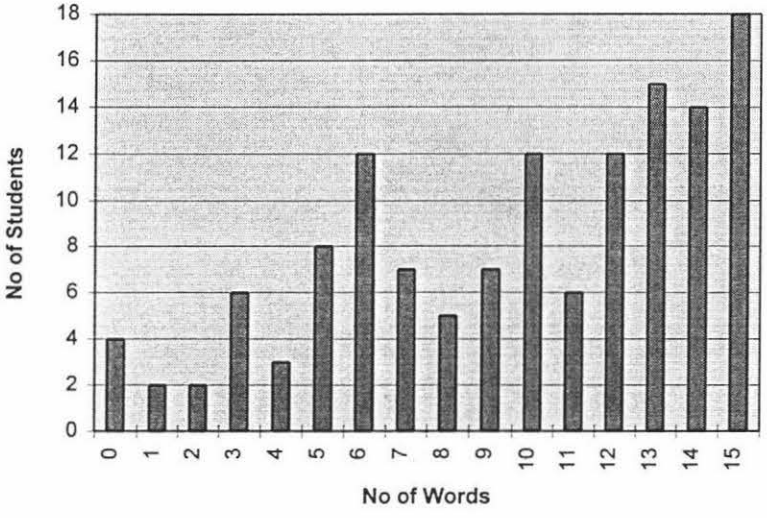

Figure 7 Sight Word Score as determined by Diagnostic Reading Survey (n=120)

The Sight Word Score section of the survey measures the size of the vocabulary which the student has acquired by counting the number of words that he/she gets correct from a list of the most commonly used words in the reading texts. (See Appendix 5 for lists of words) It is to be expected that students will completely master this learning therefore finally getting a perfect score. Reference to the Stanine scores for this test show that at age six the average student will have a vocabulary of 13 to 14 words. The students in the sample had an average of 9.6 words (SD 4.279) with 33.3% (40) having a score of 13 to 15. 37.5% (45) between 6 and 13 and 29.2% (35) knowing six or less words. The students in the sample were therefore able to read fewer words than could be expected for their age.

Vocabulary Scores

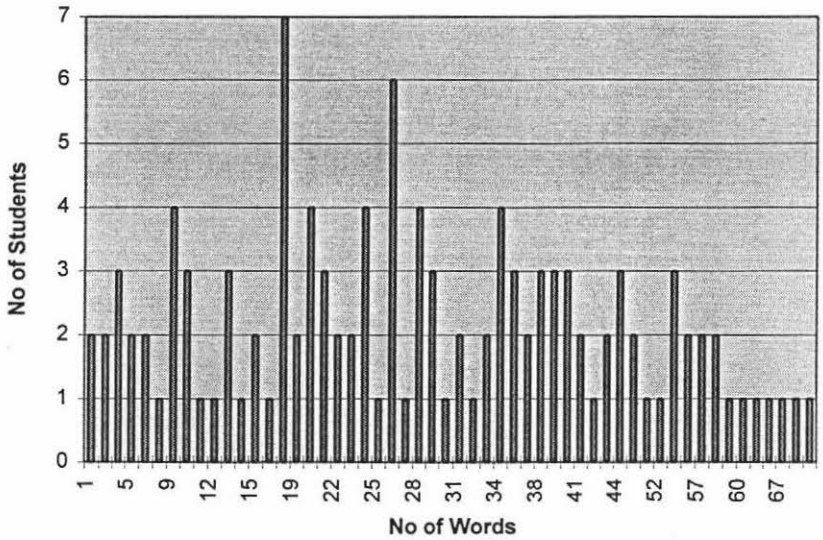

Figure 8 Vocabulary Score as determined by Diagnostic Reading Survey (n=120)

In the Vocabulary section of the survey the student is encouraged to write down all the words she/he knows how to write. This is a measure of how quickly a student is building a personal writing vocabulary which they can encode accurately and rapidly independent of text or prompts. The Stanine norm for this test is reported as 36 to 45 words however other samples by Robinson (1973 cited in Clay 1993 p 60) have means of 26.5 and 30.3 which are considerably lower. In the sample the mean number of words was 29.6 (SD 17.863) which equates with these last two norms rather than the published norm. Thirty (25%) students had scores above the upper quartile of 40 and thirty (25%) had scores below the lower quartile of 17. On this section of the reading test the students were performing as expected.

Dictation Scores

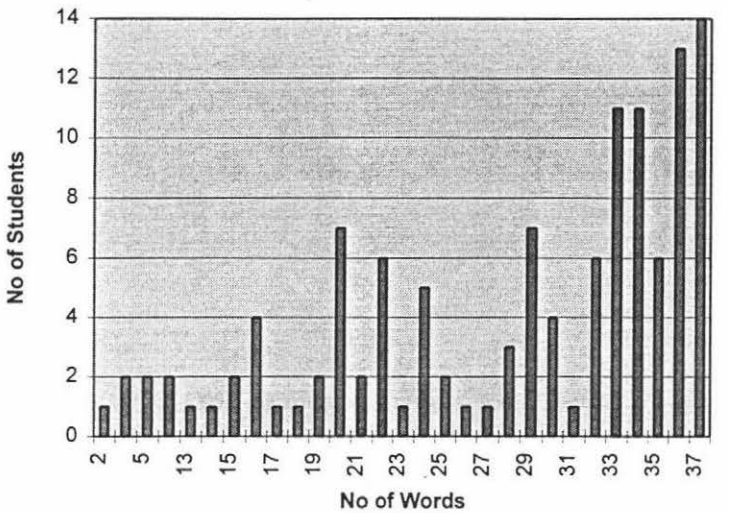

Figure 9 Dictation Score as determined by Diagnostic Reading Survey (n=120

This part of the survey determines how well a student hears and records sounds in words. The teacher asks the student to write a dictated sentence and then scores a point for each sound (phoneme) that the student records correctly. The sentence is chosen from the samples supplied and each consists of 37 phonemes. (See Appendix 5 for examples of text) The norm for this part of the test based on Stanines is between 28 and 31 words. In the sample group the mean was 28 (SD 8.838)with 72 (60%) students scoring above this. On this part of the reading survey therefore the students performed as expected.

COMPARISON OF DIAGNOSTIC READING SURVEY RESULTS AND EAR STATUS

Ear Function Tests with Reading Level

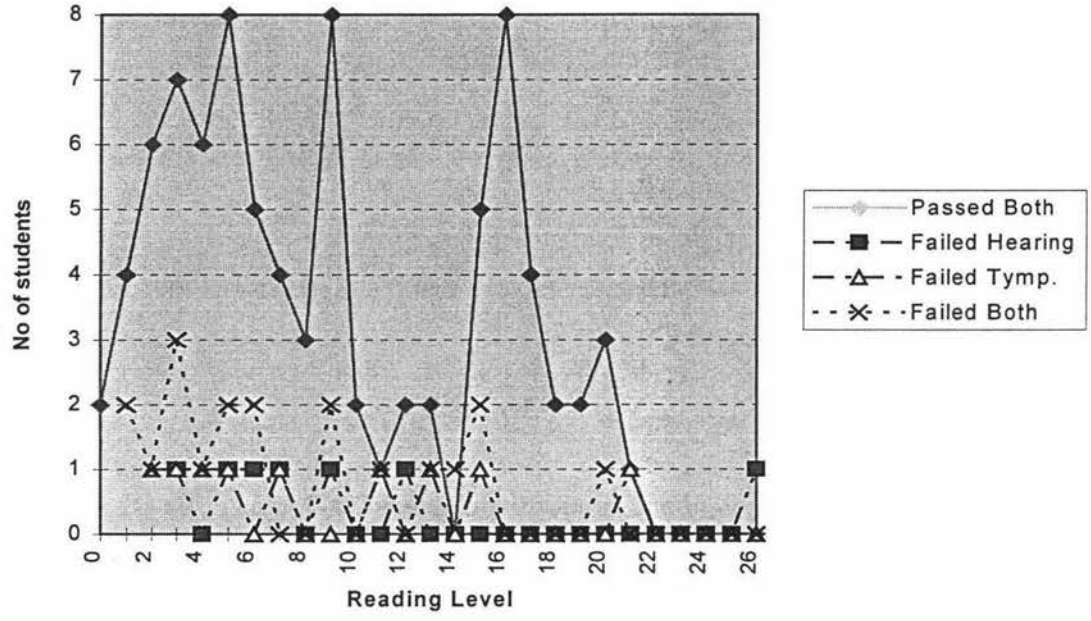

Figure 10 Reading Level compared to Ear Function Tests (n=120)

Except for two, all students who failed both ear function tests or failed only the tympanometry test had reading levels of 15 and below. Those who failed only the hearing test had reading levels of 12 and below. This indicates that the hearing test is a better indicator of later reading difficulties than the tympanometry test. No statistically significant difference was found when the results of the hearing tests and the reading levels were compared using ANOVA and Student Newman Keuls (SNK) procedures.

Number of Infections compared to Reading Levels

Students were sorted into three groups depending on the number of ear infections suffered. The 43 students with no recorded infections were classed as without infection, 59 students with ten or less infections were classed as low infection and 18 students with more than eleven infections were classed as high infection.

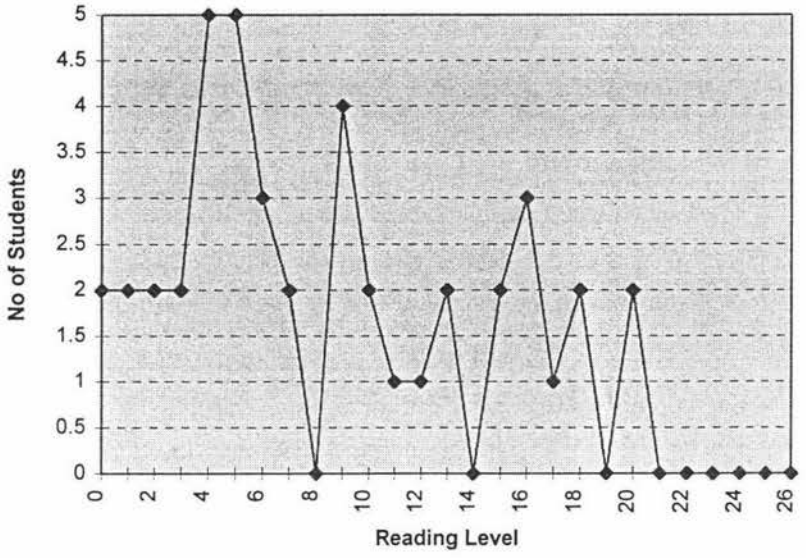

Figure 11 Reading Levels of Students without infections. (n=43)

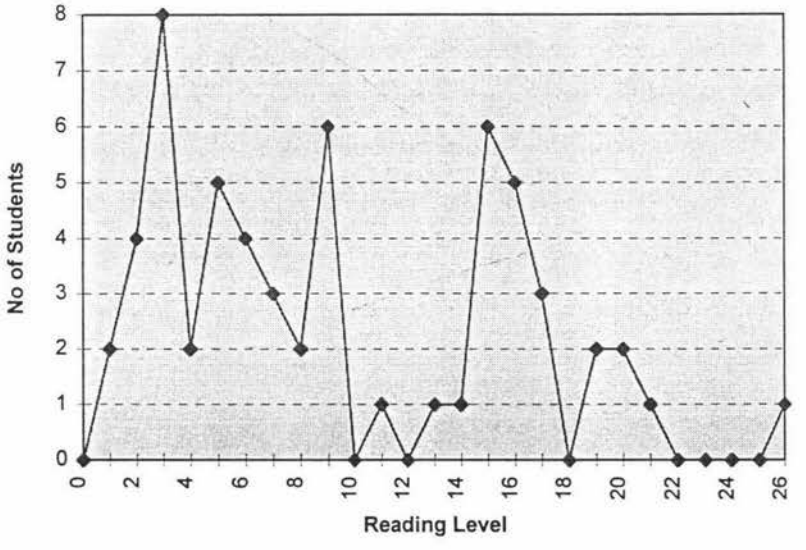

Figure 12 Reading Level of Students with Ten or Less Infections. (n=59)

Figures 11 & 12 show the ranges of achievement for the no infection and low infection groups. These two groups have a similar spread of students among the reading levels with means of 9.0 for the no infection group and 9.3 for low infection group with medians of 8 and 8.5 respectively. These results are similar to the results for the whole group.

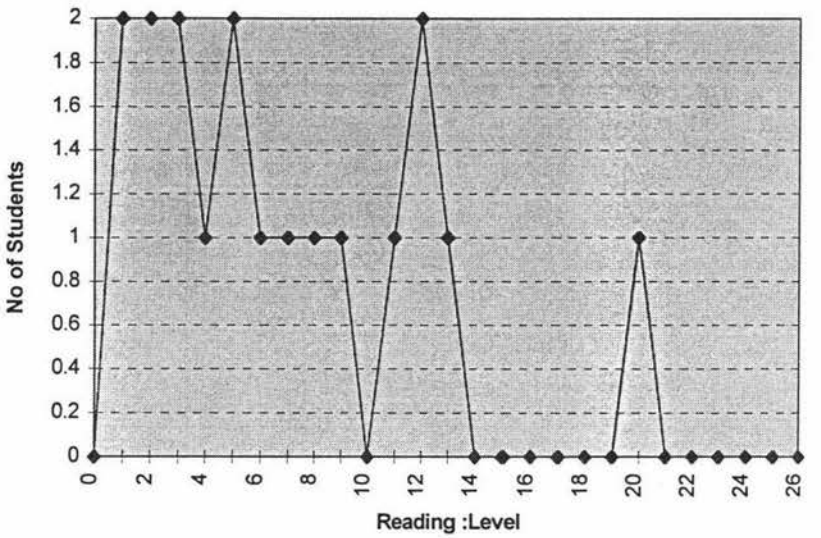

Figure 13 Reading levels of Students with more than Ten Infections (n=18)

Figure 13 shows that students in the high infection group were reading at lower levels than the other two groups. The mean for this group was 6.2 and the median 4.5.

A *t* test of significance showed that the difference between the reading levels of the high infection group and the no infection group was not statistically significant.

Table 6 History of Students with Grommets (n=10)

Student No	Age of First Infection	Number of Infections	Age of Last Infection	Age when Grommets Fitted	Hearing Test	Tymp. Test	Reading Level	Word Test	Vocab	Dictation
1	8	20	still	14	Fail	Pass	12	14	36	35
2	6	10	still	24	Pass	Pass	4	10	26	29
3	1	20	36	36	Pass	Pass	12	11	24	29
4	12	25	still	48	Pass	Pass	2	6	12	13
5	9	25	50	50	Retest Once	Retest Once	3	3	13	22
6	24	2	66	60	Pass	Pass	15	14	28	32
7	54	12	still	60	Retest Twice	Fail	7	6	23	33
8	36	10	still	72	Pass	Pass	4	6	15	22
9	36	25	still	75	Retest Once	Fail	1	6	9	20
10	36	15	78	78	Fail	Pass	6	10	41	20

(Ages in months)

The effects of wearing grommets

Table 6 shows some interesting trends. Although the reading levels range from 1 to 15 with a mean of 6.6 and median of 5.0 all but three students were at level 7 or less. Of the students with a reading level higher than 7, two had grommets fitted relatively early i.e. 14 and 24 months and the third suffered only two infections with the first not occurring until 24 months of age.

Comparing students 1 and 5, who had their first infection at about nine months, both had multiple infections. However student 1 had grommets fitted at age 14 months and now has a reading level of 12 whilst student 5 did not have grommets fitted until the age of 50 months and has a reading level of 3. Student 1 continued to have repeated infections after the grommets were fitted whilst student 5 had no further infections after the grommets were fitted. Interestingly, student 1 failed the hearing test at age five but passed the tympanometry test indicating that there was residual deafness at the time of the test. Grommets do not prevent ear infections occurring, they act as a drainage channel so that fluid cannot accumulate in the middle ear and cause deafness. Student 5 failed both tympanometry and hearing tests on the first occasion of testing but passed on a second test. The parent commented that the student had had too many ear infections to count but that these ceased after the grommets were inserted.

Students 7 & 9 failed the tympanometry test and subsequently had grommets fitted.

Examination of the raw data showed an appreciable difference between students with grommets and those without grommets on the scores of the Diagnostic Reading Survey. However no statistically significant difference was shown when the results were analysed using ANOVA and Student Newman Kreuls (SNK) procedures.

Table 7 Summary of Data on Ear Function Tests, Number of Infections and Reading Survey

		Grommets (n=10)		High Infection (n=11)*		Low Infection (n=56)*		No Infection (n=43)*		Failed Tymp (n=25)*		Failed Hear (n=19)*	
			SD		SD		SD		SD		SD		SD
Reading	Mean	6.6	4.565	7.6	5.598	9.7	6.341	8.5	5.752	9	5.839	9	6.785
Level	Median	5.0		5.0		8.5		7		7		6	
Word Test	Mean	8.6	3.555	7.6	4.791	10	4.073	9.7	4.413	9.5	4.691	9	4.934
	Median	8.0		7		12		10		11		11	
Vocabulary	Mean	22.7	10.042	23.9	16.178	33.8	19.544	27.7	16.16	30.6	17.870	32	24.148
	Median	23.5		21		29		28	2	28		32	
Dictation	Mean	25.5	6.742	21	11.678	29.6	7.5733	27.9	9.158	28	10.123	27	11.065
	Median	25.5		19		33		32		33		32	

(* = without students with grommets) (High Infection = 1-10, Low Infection = >10 Fail=Fail & Re-test Once or Twice)

Table 8 Results for Whole Group and Sample Group

		Whole Group (n=120)		Sub-Group** (n=37)	
			SD		SD
Reading	Mean	9	5.999	8.5	5.953
Level	Median	7		7	
Word Test	Mean	9.6	4.279	9.4	4.658
	Median	9.5		10	
Vocabulary	Mean	29.6	17.863	27	16.493
	Median	27		26	
Dictation	Mean	28	8.831	27	9.581
	Median	31		32	

(** Students who passed both Ear Function Tests without ear infections)

COMPARISON OF DIAGNOSTIC READING SURVEY RESULTS, EAR FUNCTION TESTS AND NUMBER OF INFECTIONS

From Tables 7 and 8 and using the sub-group (students who passed both Ear Function Tests and did not have a history of ear infections) as a control several trends emerged.

Reading Level

Students with grommets had the lowest mean reading level of 6.6 and the high infection group with 7.6 was next. All other groups had a similar mean reading level around 9 ranging from 8.5 for the control and no infection groups to 9.7 for the low infection group. Analysis of these results using the *t* test, ANOVA and SNK procedures, however, showed no significant difference between any of the groups on the mean reading level scores. As the scores for the whole group were at the lower end of the range expected for their age group the students with grommets were reading at levels well below the national norm.

The group who failed the hearing test and the group who failed the tympanometry test had very similar results to each other and to the group as a whole.

Word Sight Test

No apparent differences can be seen with the Word Sight Test as all groups have a similar score of around 9.0. This score is considerably less than the standard score of 13 - 14 words. Statistical analysis with ANOVA and SNK procedures supported these findings. This test has an upper limit and with time all students should be able to achieve a perfect score so any differences in ability may not be noticeable.

Vocabulary Test

On the Vocabulary Test both the grommet and high infection groups appear to have considerably lower scores than all other groups, 22.7 (grommets) and 23.9 (high infection) compared to 27 for the sub-group and 29.6 for the whole group. As the group as a whole tended to score slightly higher than the standard score on this section of the test it suggests that the students with grommets and those with multiple infections were

affected. Statistical analysis using the *t* test, SNK and ANOVA procedures however did not support this finding as no significant differences were found between the scores.

Dictation Test

The high infection group had the lowest mean score (21) on the Dictation Test with the grommet group having a mean score of 25.5. All other groups had scores around 28. The effect of multiple infections on the Dictation Scores was shown to be statistically significant. The Correlation Coefficient was -0.2943 indicating that as the number of infections increases the Dictation Score decreases. Analysis using the SNK procedure supported this result showing significant differences between the high, low and no infection groups on the Dictation Score (prob. 0.050) Further analysis comparing the results of the tympanometry results and number of infections with the results of the Diagnostic Reading Survey showed significant differences on the Dictation Scores between the group who failed the tympanometry test and were in the high infection groups and all other groups (prob. 0.050).

Analysis using the *t* test of significance found a significant difference on the Dictation Score (F=1.94, prob. 0.050) between students who failed both hearing tests and those who passed both. There was also a significant difference in the number of infections between these two groups (F=1.86, prob. 0.039) indicating that students who have multiple ear infections are more likely to fail the hearing test on school entry than those who have few or no ear infections.

From the results it appears that students with grommets (definite OME sufferers) and students with multiple infections (possible OME sufferers) were the most affected as their scores were consistently lower than the control group or the other groups.

Table 9 Results for Maori Students (n=12)

	Reading Level	Word Test	Vocab	Dictation	No Infections	Grommet	Hearing Test	Tymp Test
	0	1	1	2	0	0	0	0
	3	5	9	20	<11	0	2	2
	3	5	9	9	0	0	0	0
	3	10	17	29	0	0	2	0
	3	6	10	20	<11	0	0	0
	5	10	17	25	0	0	2	0
	5	6	17	16	>10	0	0	0
	5	12	28	35	<11	0	0	0
	6	11	33	34	0	0	2	0
	7	6	17	20	<11	0	0	0
	9	9	34	34	<11	0	0	2
	11	15	34	36	0	0	0	0
	9	12	31	29	0	0	0	0
Mean	5	8	18.8	23.3				
Median	5	7.5	17	22.5				
SD	2.858	3.674	10.597	10.435				

Table 10 Results for Pacific Island Students (n=7)

	Reading Level	Word Test	Vocab	Dictation	No Infections	Grommet	Hearing Test	Tymp Test
	0	2	2	5	0	0	0	0
	1	5	9	16	0	0	0	0
	3	10	13	22	<11	0	0	0
	4	6	20	30	0	0	0	0
	5	11	21	22	0	0	0	0
	9	12	32	33	<11	0	0	0
	9	12	31	29	0	0	0	0
Mean	4.4	8.3	18.3	22.4				
Median	4	10	20	22				
SD	3.289	14.564	10.280	8.926				

Table 11 Group minus Maori and Pacific Island Students (n=101)

	Reading Level	Word Test	Vocab	Dictation
Mean	9.6	9.9	31.9	29
Median	9	11	29	33
SD	6.176	4.3631	18.132	8.9260

THE EFFECT OF ETHNICITY

There were no failures on the ear function tests recorded for any Maori or Pacific Island students (Tables 3 & 4). The number of Maori and Pacific Island students, however, in the sample were very low. Maori 10% compared to 20.5% of the population under study and Pacific Islanders 5.8% compared to 7.7% (Tables 1 & 2). This may explain some of the findings.

This group did not record as many infections as the rest of the sample which may be due either, to infections not being recognised or, difficulties in completion of the questionnaire.

The scores on the diagnostic reading survey for Maori and Pacific Island students were very similar but lower than the rest of the sample. Comparing Tables 9 & 11 the following results were noted:

- Maori students had a Reading Level of 5.5 compared to 9.6 for Europeans. This difference was found to be statistically significant using a *t* test $t = 2.84$ (prob. 0.007).
- The score on the Word Sight Test was 8 for Maori and 11 for European however this difference was not shown to be statistically significant.
- The mean Vocabulary Test scores were 18.8 for Maori students compared to 31.9 for Europeans. This result was found to be statistically significantly different, $t = 2.19$ (prob. 0.037).
- There was no significant difference between Maori and Europeans on the Dictation Scores.

Comparing Tables 10 & 11 for Pacific Island students and Europeans the following results were noted:

- Pacific Island students had a Reading Level average of 4.4 compared to 9.6 for Europeans. This difference was found to be statistically significant using a *t* test $t = 2.79$ (prob. 0.014).

- Although Pacific Island students scored 8.3 compared to 11 for Europeans on the Word Sight test this was not proved to be statistically significant.
- There was a significant difference t =2.02 (prob 0.064) between the Vocabulary Scores of 18.3 (Pacific Island) compared to 31.9 (European).
- The mean Dictation Scores of 22.4 for Pacific Islanders and 33 for European were not significantly different.

Combining Maori and Pacific Island students in one group and comparing them with the Control group showed significant differences on Reading levels t = 3.71 (prob. 0.001), Vocabulary Scores t = 2.93 (prob. 0.050) and t = 2.43 (prob. 0.021) for Dictation Scores.

These results show that both Maori and Pacific Island students are significantly behind their peers on reading ability, have smaller personal vocabularies and greater difficulty in recording speech in print.

DISCUSSION

This study was designed to examine the possible effects of OME on emerging literacy as recorded by the scores on the Diagnostic Reading Survey. Although the results did not prove conclusively that there is a link between OME and reading ability there were strong indications to support this hypothesis.

Without access to medical records it was impossible to identify which students had been diagnosed as having OME, other than those students with grommets. For the purposes of this study therefore certain assumptions have been made and the students grouped accordingly.

Students with grommets are considered to have OME as this has been medically diagnosed. Those students who fail the tympanometry test, or have a history of multiple ear infections starting at an early age, are grouped as probably having OME. Students with a low number of ear infections are unlikely to have OME and are used as a control group for comparison purposes.

It was hypothesised that students with diagnosed OME would have lower scores on the reading tests than would normally be expected. The results for students with grommets appeared to support this prediction as they tended to be at lower reading levels than their peers and also have lower Dictation and Vocabulary scores (Tables 6 and 7). Statistical analysis of these results compared with other groups, however, showed no significant differences but the relatively small size of this group may have affected the results.

Initially Silva et al. (1985) found that if OME is diagnosed and treated at an early age the effect on language acquisition and therefore on learning to read is less. This prediction was supported by the results of this research. Students who had grommets fitted before the age of 36 months had scores on the Diagnostic Reading Survey within the range expected for their age (Levels 9 to 15). All students, except one, who had grommets fitted later had considerably lower scores than expected (Levels 1 to 7). The one exception, however, suffered only two infections the first at age 24 months and the

second at 66 months some six months after grommets were inserted and therefore possibly suffered only minimal hearing impairment.

If the critical time for language acquisition is between the age of 18 and 36 months it would appear that the earlier grommets can be fitted the less will be the effect on later learning. Fitting grommets at the age of 36 months as in the Dunedin experiment may be too late to prevent later difficulties as Silva (Allen 1991) found that the students in his sample were academically two years behind their peers at age 15.

Failing a tympanometry test usually indicates OME but in these results failure on either the tympanometry or audiometry test did not appear to have a noticeable effect on the reading test scores (Table 7).

Students who failed both hearing tests and had a history of multiple ear infections however, had statistically significant different scores on the Dictation Test from the other groups of students (Tables 7 & 8). The Dictation test is designed to assess the student's ability to hear individual sounds (phonemes) in words and to represent these by letters (graphemes). The lower score of these students on the Dictation Test strongly suggests that OME affects the ability of students to discriminate sounds within words. As this group of students is highly likely to have OME these results support the hypothesis that OME affects reading ability.

Multiple ear infections, although not always caused by OME, indicate that the sufferer is at risk of having the condition. Zinkus & Gottleib (1980) found that students with severe OME scored considerably lower on language ability than those with mild OME. In this research it was found that students with a high number of ear infections likewise scored lower than their peers on all aspects of the Diagnostic Reading Survey (Tables 7 & 8). The mean reading level for this group was 7.6 compared to a mean of 9 for the whole group and a mean of 8.5 for the sub-group (students who passed both hearing tests and no history of ear infections). Although these differences in the reading levels were not shown to be statistically significant the differences between the mean Dictation Scores were.

There was negative correlation between the number of infections and the Dictation Score showing that as the number of infections increased there was a corresponding decrease in the Dictation Score. This effect was also shown in the analysis of variance using the Student Newman Keuls procedure where there was a significant difference between the Dictation scores of the high infection group and the other two groups, i.e. low and no infection.

The low score on the Dictation Test indicates that students with multiple ear infections have impaired ability in distinguishing individual sounds in words. All ear infections cause transient hearing loss however multiple ear infections mean these students will have prolonged periods of impaired hearing. They will thus receive inconsistent phonic signals, and have difficulties in processing these, which will affect their acquisition of language and lead to difficulties when learning to read.

Incorrect processing will lead to a reduction in the number of words that a student has in her/his personal vocabulary which will mean that they cannot rely on cues and previous word knowledge when interpreting text. This cumulative effect of multiple infections on hearing was demonstrated when the results of those students who failed the hearing test were compared with those who passed. Statistical analysis showed there was evidence of a greater number of ear infections in the failing group and a significant difference between the Vocabulary scores of the two groups.

Data in New Zealand indicates that there is more OME amongst Maori and Pacific Islanders than Europeans as these groups have higher failure rates in hearing tests at school entry (NZ Hearing Screening Statistics 1993). It is suggested that this may account for the lower academic achievement of these groups. Because of the small number of Maori and Pacific Island students in the sample and the relatively few apparent ear infections suffered by this group it is impossible to examine the effects of OME in these students. It was found however that the results of this group on the reading test were considerably lower than the rest of the sample. Statistical analysis of the results showed that both Maori and Pacific Island students had significant

differences on both the Reading Level and Vocabulary sections of the Diagnostic Reading Survey.

Comparing the results for Maori and Pacific Island students combined with the results of the rest of the group showed statistically significant differences on the Reading Levels, Dictation and Vocabulary section results. In this sample both Maori and Pacific Island students showed considerably lower achievement with regard to reading than other students. As there is little evidence in the present research to support a higher incidence of OME amongst this group it suggests that factors other than OME contribute to the lower academic achievement of these students as was found by Feagans and Pollock (1994).

LIMITATIONS

The results of this research should be interpreted keeping the following limitations in mind as these may affect the validity of the results.

The response rate for the questionnaires was 68.2% which means that nearly a third of the forms was not returned. The Privacy Act 1993 does not allow access to the names and addresses of the students in the sample therefore it is impossible to identify which parents did not return forms and thus analyse the reasons for non return of questionnaires.

The design of the questionnaire produced answers which were difficult to interpret with a high degree of accuracy. The questions should have been closed rather than open ended. For example *"How many more ear infections would she/he have had since then?"* produced answers such as *"lots" "too many to count" "One a week"* Redesigning the question so the parent was required to circle a range such as 0,1-5, 6-10, etc. would have been easier for the parent and increased the accuracy of the results.

The information on the number of ear infections and the age of onset and age of last infection was collected by questionnaire and relied on parents recall of the child's early

medical history. There will obviously be discrepancies in the accuracy of this information, with some parents having complete recall and others hazarding guesses when answering the questions.

OME usually resolves spontaneously by age five to seven thus some students may have had OME prior to school entry that had resolved and would not be identified on the tympanometry test on school entry. This group may well have no apparent reason for later reading difficulties but hearing loss due to OME during the pre school years may have resulted in impaired linguistic skills which could lead to later difficulties with reading.

As OME is often symptom free the no infection group could well include students with undetected OME.

Students with multiple ear infections may have had more time away from school than other students and so the lower results found with this group may be due to decreased instruction time.

The numbers in some of the subgroups, e.g. students with grommets or failing ear function tests, are small and so could affect the accuracy of the results.

There was under representation of Maori and Pacific Islanders in the sample and the numbers were too small to allow any inferences to be drawn regarding the effects of ethnicity on OME.

In his initial research on the effects of OME Silva et al. (1985) concluded that OME did not have long term effects on children's academic ability. However continued research on the same children, now in their twenties, has reversed this finding (Allen 1991). Clay (1991 p 14) reflects that reading difficulties are more likely to be detected at age eight therefore this research may have looked at students too early in their academic life when the effects of OME on learning had not yet fully emerged.

CONCLUSION

From the results of this research it is impossible to definitely state that OME affects the reading abilities of children as in most cases OME was not medically diagnosed. Only those students with grommets can be considered to definitely have OME. Symptoms such as multiple ear infections and failing a tympanometry test are strong indicators that OME is present but are not definite proof of the condition. However, with this proviso in mind, there is evidence from the results to support the hypothesis that OME affects reading ability.

This research found that the most significant effect of possible or suspected OME is on the Dictation Test score of the six year old Diagnostic Reading Survey. This section of the survey measures the ability of a student to distinguish sounds in words. Success is reliant on the student being able to recognise phonemes (the individual sounds which make up words) and to be able to represent these as graphemes (written manifestations of phonemes). By affecting hearing, OME reduces the auditory discrimination of the student to distinguish the component sounds in a word. This leads to later difficulties when the student is learning to read as it is necessary to know how words sound before they can be recognised in print. Interference with hearing during the critical time of speech acquisition, i.e. between 18 months and 3 or 4 years of age means the student does not acquire a large vocabulary or essential speech letter sounds essential for later learning.

There is strong support from this research to suggest that the earlier OME is diagnosed and treated the less the effects will be on later academic achievement. Students who had grommets fitted before the age of 36 months were more likely to be reading at the correct level for their age than those students who had grommets fitted later.

There is also evidence that multiple ear infections affect reading ability and that all ear infections should be treated promptly. The practice of waiting until children grow out of ear infections is to be deplored as it can affect their later learning and academic development. As Quick and Mandell (1983) note most development of speech take places before the age of three years of age and OME at this time could inhibit language

acquisition with later effects on academic achievement. Maw (1987) reported that about 70% of OME occurs before the age of three years.

There was no evidence from this research to support the belief that the incidence of OME is higher in Maori and Pacific Island students, although scores for these students on the Diagnostic Reading Survey were significantly lower than their peers.

OME is only one of the many factors which affect learning to read. Socio-economic status, family background, temperament, teacher-pupil fit and ratio all affect the student and the teaching process. Thus there will be other unidentified factors which will have affected the reading level of the students in the sample and it is impossible to state that the effects observed are due entirely to OME.

Early identification of children at risk of later learning difficulties due to OME will benefit both individual children and society. As Paris and Oka (cited in Chapman and Tunmer 1991) observed children who experience difficulties in reading have decreased motivation and eroded feelings of self worth. If OME can be identified as a cause of reading difficulties this can be dealt with before negative feelings are established. It will also allow valuable resources and Reading Recovery to be freed for dealing with other learning disadvantaged children whose problems are not due to OME.

As OME does not always present with obvious symptoms regular tympanometry testing of all pre-schoolers from the age of 18 months should be accepted practice. This is the age when the basis of speech and language is being acquired and impaired hearing at this time has long term consequences. The recent move to test all children in pre-school and day care at age three is a start but many children miss this test. Referral is usually made after a student has failed three tests which means it may be six months before a child is medically examined and an even longer time before the child has grommets fitted. There should be immediate access to medical care for those children who require grommets. A very simple operation can make the difference between a child who becomes an academic failure and a child who is able to achieve to the best of his/her potential.

APPENDIX ONE

Letter to Parents

August 1994

Dear Parent/Guardian

My name is Diana Drumm and I am a student at Massey University. My supervisors are Clive Harper and Lois Wilkinson. As part of my studies I have to do a project on teaching and learning.

Because of the importance of reading in overall school progress children should enjoy learning to read. Overseas research has shown that ear infections or glue ear in childhood may interfere with early reading progress.

I wish to see if there is a link between ear problems and progress with reading. Your child's school and the Public Health Service have given permission to me to carry out this research.

In the Hutt Valley the Public Health Service tests the hearing level of all children at age three and on starting school. In New Zealand all children have a reading test carried out about the time that they have their sixth birthday. It is children in this age group that I am interested in for my research.

Your child has had a six year old reading test in the last two terms. I would like you to allow me to:

- look at your child's record card and reading result kept at the school and
- the hearing test results kept by the Public Health Service at Hutt Valley Health.

If you are willing to give me permission to look at your child's records to collect this information only could you please sign the consent form which is with this letter.

As parents know most about their child's health I would be grateful it if you could also answer the questions about your child on the form with this letter.

If you do not want to answer these questions but are willing to let me read your child's records please return the consent form only.

If you do not want me to look at your child's records then do not return the forms but thank you for taking the time to read this letter.

Please place the forms in the envelope provided and return this to your child's teacher.

All information will be treated confidentially and no one will be able to identify your child in the results or any publications of my research All information collected will be destroyed after this project is finished. A copy of the final results will be made available to you at your child's school.

I am happy to answer any queries you may have on this topic. If you have any questions or require any help you can telephone me on 566 6224.

Thank you for your help.
Yours sincerely

Diana Drumm

Consent Form

Consent Form

I have read the letter about this study. I understand that the aim of the research is to see if a link exists between learning to read and a history of ear problems. I understand that I can ask questions about the study at any time.

I also understand that access is to the records only and that neither I nor my child will be approached for any other information than that which I have already provided on the information sheet which is enclosed with this form. It has been explained to me no one will be able to identify my child or the school from the results or any publication arising from this project.

It has been explained to me that all the information obtained will be treated in confidence and that at any time I have the right to withdraw my permission for my child's results to be used. In addition I understand that I have access to my child's records at any time, including when they are held by the researcher, in order to correct any of the information about my child which is on the records.

I give permission for Diana Drumm to access the following records about my child ..... for the purposes of her research and any publications which may arise from this.

- School record card
- Reading test results
- Hearing screening result

(All held by School)

- Ear screening results held by the Public Health Service at Valley Health

Signed Date

Parent/Guardian please cross out whichever does not apply)

Please put this and the information about your child's health form in the envelope provided and return to your child's teacher by **FRIDAY AUGUST 26**

Questionnaire

INFORMATION ABOUT YOUR CHILD'S HEALTH

I would appreciate it if you could answer the following questions. You have the right to refuse to answer all of the questions or any particular question.

1. Has your child ever had grommets or tubes fitted in his/her ears

Yes/No

If you answered **No** go to Question **5**

If you answered **Yes** answer the following questions 2 -4

2. Was this in one ear ? Yes/No

or both ears? Yes/No

3. How old, approximately, was your child when the grommets or tubes were fitted?

4. Did your child have the grommets or tubes fitted because of:

(a) ear infections Yes/No

(b) discharging ears Yes/No

(c) glue ear Yes/No

(d) difficulties in hearing Yes/No

Now go to Question 6

If you answered **No** to Question **1** answer the following questions

5. Has your child ever suffered from:

(a) ear infections Yes/No

(b) discharging ears Yes/No

(c) glue ear Yes/No

(d) sore ears Yes/No

(e) difficulties in hearing? Yes/No

If you answered **No to <u>all</u> of the above** go to Question **10**

If you answered **Yes to <u>any</u> part of question 5** go to Question **6**

6. At what age approximately did the first ear infection / ear trouble occur?

7. How many more ear infections / ear troubles would she/he have had since then?

8. Is your child still suffering from any of the complaints listed in Question 5 ?

Yes/No

If you answered **No** at what age did the ear infections / ear trouble stop?

10 Have any other members of your family suffered from ear infections/problems?

Yes/No

If you answered **Yes** was it Sister/brother/parent/or other relative?

(Please tick which applies)

Thank you for taking the time to answer these questions.

If you have any queries please feel free to contact me.

Diana Drumm (Telephone 566 6224)

Please put this and the consent form in the envelope provided and return the envelope to your child's teacher by **FRIDAY AUGUST 26**

Letter to school principal

335 Waterloo Road
Lower Hutt
....August 1994

Bill .....
The Principal
.....School
.....Street
.....

Dear Bill

Thank you for talking to me on the telephone today and as promised I am sending further information about my proposed research.

I am currently studying for a Master of Education (MEd) through Massey University. My supervisors are Lois Wilkinson and Clive Harper. For my MEd thesis I wish to investigate whether or not there is a connection between episodes of glue ear during childhood and later difficulties in learning to read. I enclose a brief summary of the background to my proposed topic.

I have received approval from Massey University Human Ethics Committee for this research. I have also received permission from the Public Health Service to access, with parental permission, the child's pre school audiometry test results held by them but understand that the results of the hearing tests on school entry are on the child's school record card.

I would like permission from you and your trustees to approach parents or guardians of six year old pupils at your school, who have had a reading test in term three of 1993 and term one of 1994, for permission to access information held about their child.

The information I would require is:

- access to the child's school record card including data held by the school on the child's reading level at age six,
- the hearing test results held by the Public Health Service at Valley Health

I would ask you, on my behalf, to distribute letters to the parents seeking their permission for me to access the information I require. I enclose a copy of the letter and forms which I propose to give to the parents.

I am rather concerned about the length of the letter to the parents but as I included all the information which the Public Health, the Privacy Act and the Ethics committee required it kept getting longer. I am presently conducting a pilot study with one school as to how the forms are accepted by the parents. I would be grateful for your comments on this matter.

When permission is gained from the parents I would ask you to allow me access to the records held by the school at a mutually convenient time.

All information obtained will be treated in the strictest confidence and the results will be presented in such a way that neither the school nor any individual child could be identified. All material collected will be destroyed on completion of the thesis.
I will keep you informed of the progress of the research and the final results will be available to you.

If you think it is necessary, I could visit you and/or your board of trustees to give a presentation about my topic.

If you wish for more information please telephone me on (04) 385 9604(Work except Tuesdays) or (04) 566 6224 (Home) I will telephone next week for your answer.

Kind regards
Yours sincerely.

Diana Drumm BPharm, BEd, MPS

APPENDIX TWO

Stanine Scores for Diagnostic Reading Survey

APPENDIX 2

New Zealand Stanine Score Summary Sheet

'Ready to Read' Word Test

320 urban children aged 5:0–7:0 in 1968	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0	0	1	2–5	6–12	13–14		15	
282 urban children aged 6:0–7:3 in 1978	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0–1	2–5	6–9	10–12	13–14		15		

Letter Identification

320 urban children aged 5:0–7:0 in 1968	Stanine group	1	2	3	4	5	6	7	8	9
	Test score		0	2–7	8–25	26–47	48–52	53	54	
282 urban children aged 6:0–7:3 in 1978	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0–13	14–28	29–43	44–49	50–52	53		54	

Concepts About Print

320 urban children aged 5:0–7:0 in 1968	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0	1–4	5–7	8–11	12–14	15–17	18–20	21–22	23–24
282 urban children aged 6:0–7:3 in 1978	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0–9	10–11	12–13	14–16	17–18	19	20–21	22	23–24

Writing Vocabulary

282 urban children aged 6:0–7:3 in 1978	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0–13	14–19	20–28	29–35	36–45	46–55	56–70	71–80	81–

Hearing and Recording Sounds in Words (Dictation Task)

282 urban children aged 6:0–7:3 in 1978	Stanine group	1	2	3	4	5	6	7	8	9
	Test score	0–3	4–9	10–17	18–27	28–31	32–35		36–37	

APPENDIX THREE

Record Sheets for Diagnostic Reading Survey

Reading Level

RUNNING RECORD SHEET

Name: _____ Date: _____ D. of B.: _____ Age: ____ yrs ____ mths

School: _____ Recorder: _____

Text Titles	Running words / Error	Error rate	Accuracy	Self-correction rate
1. Easy		1:	%	1:
2. Instructional		1:	%	1:
3. Hard		1:	%	1:

Directional movement _____

Analysis of Errors and Self-corrections
Information used or neglected [Meaning (M) Structure or Syntax (S) Visual (V)]

Easy _____

Instructional _____

Hard _____

Cross-checking on information (Note that this behaviour changes over time)

Analysis of Errors and Self-corrections
(see *Observation Survey* pages 30–32)

Page		E	SC	Information used: E MSV	Information used: SC MSV

Word Test Score Sheet

WORD TEST SCORE SHEET

Use any **one** list of words.

Date: _____

Name: _____ TEST SCORE: ____ /15

Age: _____ Date of Birth: _____ STANINE GROUP: ____

Recorder: _____

Record incorrect responses beside word

LIST A	LIST B	LIST C
I	and	Father
Mother	to	come
are	will	for
here	look	a
me	he	you
shouted	up	at
am	like	school
with	in	went
car	where	get
children	Mr	we
help	going	they
not	big	ready
too	go	this
meet	let	boys
away	on	please

COMMENT:

Dictation Score Sheet

HEARING AND RECORDING SOUNDS IN WORDS (DICTATION TASK)
OBSERVATION SHEET

Date: _____

Name: _____ Age: _____

Recorder: _____ Date of Birth: _____

TEST SCORE _____ /37

STANINE GROUP: _____

(Fold heading under before child uses sheet)

COMMENT

Vocabulary Score Sheet

WRITING VOCABULARY OBSERVATION SHEET

Date: _____

Name: _____ Age: _____

Recorder: _____ Date of Birth: _____

TEST SCORE: ☐

STANINE GROUP: ☐

(Fold heading under before child uses sheet)

COMMENT

Summary of Diagnostic Reading Survey

Sheet One

SHEET 1

OBSERVATION SURVEY SUMMARY SHEET

Recommended for survey checks after one year of instruction

Name: _____ Date: _____ D. of B. _____ Age: ___ yrs ___ mths

School: _____ Recorder: _____

Text Titles	Running words / Error	Error rate	Accuracy	Self-correction rate
1. Easy		1:	%	1:
2. Instructional		1:	%	1:
3. Hard		1:	%	1:

Directional movement _____

Analysis of Errors and Self-corrections
Cues used or neglected [Meaning (M) Structure or Syntax (S) Visual (V)]

Easy _____

Instructional _____

Hard _____

Cross-checking on cues (Note that this behaviour changes over time)

LETTER IDENTIFICATION ___ 54

CONCEPTS ABOUT PRINT *SAND* *STONES* ___ 24

WORD TEST (CLAY) LIST A _____ LIST B _____ LIST C _____ 15

OTHER READING TEST _____

WRITING SAMPLE	WRITING VOCABULARY	HEARING SOUNDS IN WORDS (DICTATION)	STORY	SPELLING
Language:		A		
Message:		B		
Direction:		C		
		D		
		E		
		37		

Summary of Diagnostic Reading Survey

Sheet Two

SHEET 2

Useful strategies on text:

Problem strategies on text:

Useful strategies with words:

Problem strategies with words:

Useful strategies with letters:

Problem strategies with letters:

SUMMARY:

SIGNATURE: _____

APPENDIX FOUR

Reading Book Scale

Approx. Reading Level (Age)	Reading Recovery Level	Indicated by original Ready to Read Series			New Ready to Read Titles	Other Titles
8-8.5	26	SF	2	(5-8)	Journal Pt. 2	Story Box Series
	25	SF	1	(1-4)	Stories for You Pt. 3 & 4	
8	24	SS	2	(4-7)	Journal Pt. 1	More More More
	23	SS	1	(1-3)	Now for a Story Pt 1 & 2	Tiddalik (Gold)
7.5-8	22	SP	2	(5-8) Gold	Night is a Blanket The Great Grumbler	Fiddle Dee Dee Cooking Pot (Dark Blue)
	21	SP	1	(1-4)	Dog Talk Journal Pt 1 Stories for You Pt 1 & 2	
7-7.5	20	DE	2	(4-6) Purple	Nanas in the Plum Tree Giant Soup	Well I Never Sing to the Moon
	19	DE	1	(1-3)	Maui and the Sun Crinkum Crankum The Rescue Junior Journal	(Lt Blue)
6.5-7	18	BD	2	(3-5) Big Blue	Pets Horrakapotchkin	Fast and Funny Just Like Me
	17	BD	1	(1-2)	Poru has a Bath	(Olive)
6-6.5	16	HL	2	(3-4)	The Big Bed	Let Me In
	15	HL	1	Orange (Stories 1,2)	Number One Pita's Birthday Matthew Likes to Read	Sun Smile (pink)
	14	Green 3			Thank You	Help Me
	13	Green 2			Paul	Roly Poly
	12	Green 1			Fasi Sings & Fasi Fish The Wild Wet Wellington Wind	(Brown)
	11	Dark Blue 3			Pets	
	10	Dark Blue 2			Blackbirds nest	
	9	Dark Blue 1			Saturday Morning Greedy Cat	
5.5-6	8	Yellow 3			T. Shirts	
	7	Yellow 2			Rosie at the Zoo	
	6	Yellow 1			The Hogboggit Did You Say Fire Nicks Glasses	
	5	Red 3			Rain Rain	
	4	Red 2			My Bike	
	3	Red 1			Old Tuatara The Biggest Cake in the World Fantail Fantail	
5-5.5					The Wind Where is Miss Pool The Smile	
	2	Caption 2 - lines			Sams Mask	
	1	Caption 1 line			Greedy Cat is Hungry	
	0	Dictated Text (Magenta)			Our Teacher Miss Poole I Can Read Going to the Beach Fun With Mo and Toots Boots for Toots	

APPENDIX FIVE

Word List for Sight Word Section of Diagnostic Reading Survey

One list is used

LIST A	LIST B	LIST C
Practice Word the	Practice Word said	Practice Word is
I	and	Father
Mother	to	come
are	will	for
here	look	a
me	he	you
shouted	up	at
am	like	school
with	in	went
car	where	get
children	Mr	we
help	going	they
not	big	ready
too	go	this
meet	let	boys
away	on	please

Text For Dictation Section of Diagnostic Reading Survey

Alternative sentences

Select one of the following alternative Forms; A, B, C, D, or E.

Form A

I have a big dog at home.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Today I am going to take him
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

to school.
34 35 36 37

Form B

Mum has gone up to the shop.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

She will get milk and
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

bread.
34 35 36 37

Form C

I can see the red
1 2 3 4 5 6 7 8 9 10 11

boat that we are going
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

to have a ride in.
27 28 29 30 31 32 33 34 35 36 37

Form D

The bus is coming. It
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

will stop here to let me
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

get on.
33 34 35 36 37

Form E

The boy is riding his bike.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

He can go very fast on it.
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37

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