Applying a Neuropsychological Framework to the Assessment of Children with Learning Disability

by

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2001

Declaration

"This thesis has been composed by myself and the work contained herein is my own"

Signed:

This thesis is dedicated to Malcolm.

ACKNOWLEDGEMENTS

I am extremely grateful to the following people for the help I received when conducting the research and writing the thesis.

Dr. Alison Clark for her enthusiastic and motivational skills, Mr Ken Laidlaw and Prof. Mick Power for additional and valuable academic support; Dr D. Manders for help with the initial idea and liaison with the school; Prof. J. Wishart, Bob Whalley, George Murray and Karen McKenzie for their time in initial discussions of the project; Brenda Renz for her generous contribution of test equipment, and score sheets; the head teacher, class teachers, assistants, and school administration staff, for their very hard work and support; Dr Hay, CMO, community child health staff, and the community paediatricians for additional support; and especially the children and parents who enabled the project to take place.

ABSTRACT

The current concept of learning disability is felt by many to be unsatisfactory given the narrowness of the defining criteria (Chapman and Hesketh, 2000; Greenspan, 1999; Accardo and Capute, 1998). For instance, definitions used by the World Health Organisation (1992), American Psychiatric Association (1994), and the American Association on Mental Health (1992), require the identification of only three core features of significantly below average IQ, concurrent social adaptive skill deficit, and childhood onset. However, these definitions ignore important individual factors such as aetiology, neuropsychological function, psychological and psychiatric morbidity.

Historically, this lack of specificity has meant that people with different needs have been treated as one group. In turn, this may have led to the potential misinterpretation that learning disability is caused by a general intellectual impairment, despite neuropsychological; evidence for specific cognitive deficits. Subsequently, individual impediments to learning or function may not be taken into account in service provision, and people with learning disability may not have their needs met.

This thesis suggests that a more comprehensive assessment of learning disability, that includes neuropsychological and behaviour assessment, may provide a better way of accurately identifying the needs of people with learning disability, and that relying on a Full Scale IQ Score is neither valid not reliable. To this end, twenty-three learning disabled children from the same

Special School, aged between 7 and 14, were assessed using the Wechsler Intelligence Scale for Children (3rd ed, Wechsler, 1992); the NEPSY neuropsychology battery (Korkman, Kirk and Kemp, 1998), and the Developmental Behaviour Checklist (Einfield and Tongue 1992). Results suggest that learning disability may appear to be characterised by both global and specific cognitive deficits. Thus, applying a neuropsychological framework may provide a more reliable and valid account of learning disability.

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PREFACE

Learning Disability is a collective term used to classify people with a significantly below average intelligence quotient, concurrent adaptive skill deficit, and childhood onset of disability (D.S.M.-IV, APA, 1994). This method of classification groups together a vast range of people with different causes of disability including genetic causes such as Down Syndrome and Fragile X Syndrome; perinatal and postnatal causes such as infection, hypoxia and ischaemia; environmental causes such as toxicity, deprivation, as well as traumatic brain injury when severe enough; and idiopathic or unknown causes (Hatton, 1998). Whilst classifying people in this way may be useful for planning service provision (Evers and Hill, 1999), this thesis will discuss why traditional measures used to describe and diagnose the nature and impact of impairment in learning disability are neither reliable nor valid. The main theme of this thesis then, is to investigate the usefulness of traditional methods of defining and diagnosing learning disability. In particular, the reliability and validity of current learning disability assessment methods will be investigated and compared with a neuropsychological approach to assessing underlying impairment. A neuropsychological approach, otherwise known as a brain and behaviour approach, is felt to be more appropriate because it enables the identification of a wider range of cognitive strengths and weaknesses, as opposed to general ability, and can provide this information in an individualised way. Thus, an individual picture of a person's underlying impairments such as attention, executive function and expression of behaviour, language ability, visuospatial ability, motor skills and memory can be derived.

A main debate in the field of learning disability relevant to this issue of diagnosis, centres on whether learning disability is marked by a global developmental delay, or specific cognitive deficits (Burack, Hodapp and Zigler, 1988). Global developmental theorists hold that learning disability is a single disorder. Similar developmental sequences occur in both learning disabled and non-learning disabled people, but the only difference is that this sequence is delayed in learning disability (e.g. Zigler, 1967). In contrast, the specific deficit hypothesis holds that people with learning disability are qualitatively different from those without. Specific cognitive differences exist in people with learning disability, dependent on specific aetiology (e.g. Ellis, 1969).

This debate is particularly relevant here, because much of it centres on the use of traditional IQ assessment (Burack, et al., 1988). This thesis will argue that because traditional assessment is not a reliable or valid way of explaining the nature and impact of learning disability, many of the arguments put forward to suggest a global or specific deficit are made invalid. Using a neuropsychological approach may therefore inform this debate more accurately.

Having a reliable and valid description of learning disability seems particularly important in the clinical intervention of children with learning disability. For instance, the impact of an acquired brain injury in a child is inevitably going to be different to the impact of an injury in an adult, because the damage occurs in the context of a developing brain (Holmes-Bernstein, 2000). Similarly, in a child with learning disability, the underlying neurological deficit will undoubtedly have an impact on subsequent development. So, as in childhood acquired brain injury, it is crucial to understand the nature of the impairment in learning disability, in order to maximise development potential (Stanley and Dolby, 1999). A second theme of this thesis is therefore one

of clinical service evaluation, and a brain and behaviour framework will be applied specifically to children with learning disability, to investigate better ways of assessing their clinical needs. In addition, the debate regarding global versus specific deficit will have important implications for children with learning disability because there are likely to be different ways of intervening in their care depending on whether they are thought to have global delay or specific impairments.

To summarise the themes of this thesis, the first is to investigate the theoretical link and clinical usefulness of a brain and behaviour approach to learning disability. Accordingly, the reliability and validity of current ways of diagnosing learning disability will be reviewed in section one, and compared with a neuropsychological approach in section two. Section three will deal with the second theme, which is to investigate a more reliable and valid model for the assessment of learning disabled children's needs. These themes will also have implications for the global versus specific deficit model of learning disability.

INTRODUCTION

Section One

Diagnosing Learning Disability

Current Methods of Diagnosing Learning Disability

The current British Psychological Society definition of Learning Disability is based on three inclusion criteria of significant impairment of intellectual functioning, concurrent deficit in adaptive/ social behaviour, and a childhood onset of the disability (BPS, 2001). Significantly impaired intelligence is further defined as an IQ of two standard deviations below average, (effectively this means an IQ of below 70), as measured on an individually administered test "which is recognised as being reliable, valid and properly standardised," (BPS, 2001, p4). Similar criteria are also used in most of the recognised diagnostic references such as the Diagnostic and Statistical Manual, 4th edition (DSM – IV, APA, 1995); the American Association on Mental Retardation, (Luckasson, Coulter, Polloway, et al, 1992) and the ICD-10 Classification of Mental and Behavioural Disorders, (W.H.O., 1992), with some slight variation in the IQ quotient, and definition of adaptive behaviour. Nevertheless, it has been argued that these criteria are too simplistic because important individual factors such as cause of disability, and cognitive strengths and weaknesses are ignored (Greenspan, 1999; Chapman and Hesketh, 2000). Furthermore, learning disability may be the only medically diagnosable condition that is made on the basis of test scores alone, rather than multiple sources of clinical information, (Greenspan, 1999). Consequently, using this definition to describe a markedly heterogeneous group (Chapman and

Hesketh, 2000), raises a number of phenomenological and methodological issues. In essence, this definition only seems to provide a way of classifying individuals with or without learning disability, but may not provide an adequate theoretical or clinical understanding of the disorder.

Changing Definitions on the Basis of Cultural Change

By reviewing the history of the care of people learning disability, it can be seen why such a classification has evolved. Psychometric testing arose from scientific enquiry into what makes individuals different. For instance in the 1880s Francis Galton measured the physical features, perceptions and reaction times of subjects and ranked these on a frequency distribution, to try and find out what made some people more superior than others (as cited in Kolb and Wishaw, 1990). Binet however felt that characteristics such as head size, facial features and handwriting styles did not reliably distinguish peoples' mental differences. Instead he developed tests that he thought were essential features of intelligence, designed to evaluate judgement, comprehension and reasoning. He was commissioned by the French Minister of Public Instruction in 1904 to find ways of identifying retarded children to single them out for special instruction, and in collaboration with Simon, produced a standardised battery of tests called the Binet-Simon scale in 1905, and revised edition in 1908, (as cited in Kolb and Wishaw, 1990). From this, a mental level could be calculated. This was derived from a score, of which between 80 and 90% of normal children of any given age, could achieve. Then in the USA in 1916, Terman produced a similar scale called the Stanford-Binet test in which an Intelligence Quotient was derived by dividing the mental age with chronological age, and multiplying by 100, giving us the IQ test in it's modern form (as cited in Kolb and Wishaw, 1990).

The basis of the IQ test therefore, was that it was measuring one underlying concept, thought to represent intelligence, and this was assessable using a variety of different cognitive tasks. Individual performance on one of the tasks would correlate well with all of the others and this concept of intelligence is known as 'g'.

Hence, the IQ test was invented to identify children who were at risk of educational failure so that academic intervention could be prioritised (Detterman, 1999). However, in the early part of the century ideas of racial and cultural inferiority were prevalent, and IQ testing became a popular discriminatory tool that led to the mass institutionalisation of people, perceived to be genetically inferior (Cain, Hatton, Emerson, 1998). At this time medical influences held that 'idiocy' was an organic disorder, and was therefore untreatable. Concurrent social influences held that 'idiocy,' along with other factors such as poverty, crime, and inappropriate sexual behaviour, were committed by genetically inferior people, (Cain et al, 1998). This became known as the eugenics model. Both of these influences led to the belief that such people should be restricted from society, and consequently, by the 1950's and 1960's, between 60,000 and 64,000 people with intellectual disabilities were thought to be living in institutions in the United Kingdom (Cain, et al, 1998). Medical and social factors therefore influenced the classification and the management of people with learning disability, and psychometric testing helped to facilitate this.

A major change in this approach occurred with ideas of social inclusion, (Wolfensberger, 1983; Nirje, 1969). This stemmed from general recognition of the importance of rights for individual citizens, after the Second World War (Cain, et al 1998), and psychiatric institutions were

increasingly thought to infringe on peoples rights to live in normal society with equal standing. Research also showed that the eugenics model was incorrect, in that intelligence was not exclusively heritable, (Plomin, 1999) and that a person's environment could play a crucial role in cognitive development. For example, in a review of more that 30 twin studies involving over 10,000 twin pairs, it was suggested that genetic factors accounted for approximately half of the variance in IQ scores, and environmental factors accounted for approximately one third (Bouchard and McGue, 1981). This meant that whilst intelligence had been shown to be consistently inheritable to some degree, (otherwise known as a heritable trait), inheritance did not account for *all* cases of learning disability. Up to a third of individual cases could still be influenced by environment. Plomin therefore concludes "genetic research provides the best available evidence for the importance of environmental influences. If half of the variance of *g* can be accounted for by genetics, the other half must be attributed to the environment plus error of measurement," (Plomin, 1999, p40).

Providing a supportive environment therefore became the main emphasis in the care for learning disabled people. Individualised and inclusive services were based in the community, to enable maximum development of potential and social value (Cain et al, 1998). Policies such as the government white paper 'Better Services for the Mentally Handicapped,' (1971), and the 'National Health Service and Community Care Act' (1990) ensured that alternatives to institutionalisation were put in place (Cain, et al 1998). Currently, the most recent policy review for learning disabled people, 'Same as You?' (Scottish Executive, 2000) recommends, that in Scotland, all existing learning disability institutions be closed. Most people are now placed in small community residences, or supported from home, or in the process of doing so (Scottish

Executive, 2000). A main consequence of this change in care then, has been that contemporary social influence has changed from a eugenics model to an habilitative approach, whereas the medical model has been minimised. Where the previous medical and eugenics concepts of learning disability caused "an inevitable devaluation and underestimation of potential for successful functioning," (Greenspan, 1999, p8), current concepts emphasise the importance of the social environment in ameliorating the impact of learning disability.

In this way, reconceptualising learning disability as a social phenomenon has indeed raised awareness of people's rights to social inclusion. However the actual defining criteria for diagnosing learning disability has largely remained the same for over a century.

Lack of Reliability

Failures in classification - or people who slip through the net

As previously indicated, the cut off point for measured intellectual ability, of two standard deviations below average, is an arbitrary measure that has evolved to provide a way of distinguishing between people with and without learning disability (MacMillan, Gresham and Siperstein, 1993). However, this classification does not reflect disease aetiology, nor does it describe the actual phenomenological experience, such as typical signs and symptoms. Furthermore the subdivision of intellectual disability of between 55 and 69 representing significant impairment, and IQ of less than 55 (or the equivalent of three standard deviations below average) representing severe impairment, (BPS, 2001) still fails to have diagnostic value as again it

constitutes an arbitrary classification that does not add any more qualitative information regarding the actual phenomenon of learning disability. Whilst classifying level of disability in this way may relate to prognosis, and provide some indication of future needs of an individual, Durkin and Stein argue that it is not sufficient because of a lack of "one to one correspondence between etiology and grade of intellectual deficit," (Durkin and Stein, 1996, p73). There is therefore a real risk that individuals who have an IQ of 70 or above but below the average of 100, and have significant intellectual deficit, will be ineligible for learning disability services that utilise this classification for inclusion criteria, (Greenspan, 1999).

Such individuals may therefore slip through the net because some people with certain types of disability can have levels of ability within the mild disability to normal range, but can still have clear functional deficits (Greenspan, 1999). For instance, Fragile X Syndrome results from a single gene mutation on the lower end of the X chromosome. This is thought to cause a decrease in the level of a protein required for normal cell function, possible related to synaptic pruning of the brain (Mazzocco, 2000). Significantly, the degree of mutation can vary, and the effect of the mutated gene can also be diminished in women because they have two X chromosomes. Thus, the majority of males, but only approximately half of all females with a full expression of genotype, are thought to be affected by mental retardation (Mazzocco, 2000). Consequently, the phenotypic expression of learning disability lies on a continuum, and so a substantial proportion of people with Fragile X Syndrome, may be above the diagnostic threshold for learning disability, but still have significant cognitive impairments. A similar problem can occur in people with Autism and Asperger Syndrome. For instance, Gilchrist, Green, Cox, et al., (2001) studied the development and current functioning of adolescents with Asperger's Syndrome or high functioning Autism. IQ

for subjects with Asperger's Syndrome ranged from 71 to 141; and IQ for subjects with high functioning autism ranged from 69 to 87. Nevertheless many of these adolescents still had clear communicative, social and stereotypical behaviour difficulties (Gilchrist, et al., 2001).

Changes in IQ criteria

Another issue regarding the reliability of traditional definitions of learning disability is that the arbitrary IQ measures have changed over recent years. Whilst the current definition is universally set at two standard deviations below average, (IQ of 70), before 1973 previous definitions in the USA were set at only one standard deviation below average, or 85 IQ points (Greenspan, 1999). In addition, the American Association on Mental Retardation raised the cut off point to 75 IQ points in their most recent classification (AMMR, 1992). By simply raising the IQ limit from 70 to 75, it has been estimated that the number of people in the U.S. general population that were eligible for learning disability status rose from 2% to 10% (MacMillan, et al, 1993). This apparently disproportionate increase reflects the higher prevalence of people with milder learning disability, compared to those with more moderate and severe impairments (Plomin, 1999). This change in policy therefore meant that some people could now be diagnosed with intellectual deficit, whereas prior to the policy change, they would not be. This clearly makes the reliability of an arbitrary measurement as a means of diagnosing learning disability questionable.

IQ drift

Using IQ assessment to diagnose learning disability is also unreliable because of the phenomenon of IQ drift. In a review of 73 American studies that measured intelligence involving over 7,500 subjects, Flynn (1984) showed that different cohorts of people had gained almost fourteen IQ points between 1932 and 1978. Moreover, IQ drift can occur within a shorter space of time, hence the need for revised editions of tests such as the Wechsler scales (Wechsler, 1992). As a result, newer versions of intelligence tests have tougher normative values (MacMillan, et al, 1993), so that individuals taking newer tests have to answer more items correctly to maintain the same IQ score. However, because newer tests are more stringent, they may lead to an increase in the number of positive diagnoses, and hence more people will be eligible for diagnosis of learning disability. This again suggests that arbitrary criteria used in classifying learning disability is an unreliable way of defining the true nature of the condition.

Use of tests in people with particularly low IQ

Finally, an additional issue of reliability concerns the actual tests used to determine level of intelligence. The BPS states that

> "the use of fine-grained subdivisions below an IQ of approximately 55, in the case of adults, depends on IQ figures which are hypothetical or extrapolated. There seems to be no reliable or valid psychometric instruments, for the adult population, to enable the clinician to arrive at the IQ figures needed to make these distinctions. Thus sub-

classification on the basis of IQ scores from directly administered IQ tests cannot be carried out reliably for the lowest levels of intellectual functioning," (BPS, 2001, p9).

In other words, the typical tests used to measure IQ, such as the Wechsler Adult Intelligence Scale (Wechsler, revised edition, 1981) and Wechsler Intelligence scale for Children (Wechsler, 3rd edition, 1992) are not actually designed for people with learning disability, and have not been standardised or validated using this population. The exception here is that the WAIS – III – UK (Wechsler, 1999), the most recent edition of the adult scale, has been has been validated on 108 subjects with learning disability, 46 classed with mild disability, and 62 classed with moderate disability. Nevertheless, because of the test design, it is still possible to score an IQ level without even answering any of the questions. The main difficulty here is that a person has likely to have reached floor level with this test, and the test is therefore not sensitive enough to measure a person's true ability when their ability is particularly low.

To date however, there seems to be no other tests available that would be more appropriate. The Raven's Coloured Progressive Matrices is one alternative that is often used. It assesses visual reasoning, and consists of a series of visual and spatial pattern matching and simple visual analogy problems. Concurrent validity studies have shown that the Ravens test has a moderate correlation of 0.7 with the Wechsler and Stanford-Binet intelligence tests (Spreen and Strauss, 1998). The format of the test also means that it is often suitable for people with motor and speech difficulties. Nevertheless, because it involves only one test, it is less reliable in providing information regarding strengths and weaknesses, and Spreen and Strauss (1998) recommend that it should only be used as an adjunct to more comprehensive measures. The

Leiter International Performance Scale – Revised, is also a non-verbal test purporting to measure intellectual ability. The first edition of the test was specifically designed for assessment of deaf children, and so is useful when a child has language difficulties. However, like the Wechsler scales, neither of these tests have been designed specifically for learning disabled children.

Additional evidence has shown that a learning disabled population can also be particularly unreliable to test, because both their day to day performance, and yearly performance can often fluctuate quite markedly (Wishart, 1996). Reasons for this fluctuation include cognitive instability, as well as influences of mood and motivation. Thus, any test that is suitable for *all* learning disabled people would have to have particularly special qualities in providing a reliable measure for such a wide range of intellectual abilities, given that it has to encompass several standard deviations below normal intellectual ability, as well as address individual fluctuations in performance.

In summary, traditional methods for assessing learning disability use unreliable, and inadequately designed tests for measuring intelligence. Moreover, fluctuating cut off scores, fluctuating individual performances, and inappropriate tests clearly challenge the requirements of reliability, which holds that a test should yield the same results whenever it is used (Powell, 1996). Nevertheless, ways of combating this problem of lack of reliability have been attempted in the following way.

Improving Reliability

In answer to some of these issues regarding reliable classification of learning disability, most of the traditional methods of assessing learning disability have now adopted the concept of dual defining criteria. Previously, people could be classified as learning diabled,soley on the basis of an IQ score. However, more recent classifications now require a measure of adaptive behaviour as well as IQ. This has occurred in recognition that "the existence of intellectual limitations alone was not sufficient for a diagnosis of mental retardation," (AMMR, 1992, p9). For instance, the BPS states that a person has impaired social or adaptive functioning if "the individual requires significant assistance to provide his / her own survival (eating and drinking needs and to keep himself / herself clean, warm and clothed) and / or with his / her social / community adaptation (e.g. social problem solving, and social reasoning)." (BPS, 2001, p6) Similarly, the AMMR requires that a person has substantial limitations in at least two adaptive skill areas of "communication, self-care, home living, social skills, community use, self direction, health and safety, functional academics, leisure and work," (AMMR, 1992, p6). Practically, a person is therefore judged on how well they can maintain and sustain themselves as an independent person by managing activities of daily living such as self- care and safety. Socially, a person is judged on how well they understand social expectations and the behaviour of others, and how well they judge social situations in order to act appropriately, which includes the need for insight, judgement and communication, (AMMR, 1992, p15). In sum, IQ is felt to represent conceptual intelligence, whereas adaptive behaviour represents practical and social intelligence.

This dualistic criteria helps to prevent false positive and false negative diagnoses of learning disability that can occur in individuals whose IQ score lies around the designated cut off point. For instance, by using a social adaptive criteria, individuals who have both low IQ and social adaptive functioning can be more accurately identified as being learning disabled, so preventing false negative diagnoses. Individuals with a higher than cut off IQ score, but lower social adaptive functioning, can also be more clearly identified to prevent false positive diagnosis. Nevertheless, as Greenspan argues

> "the direction of the dual criterion system remained such that one's adaptive behaviour level could cause one to be 'non-MR' [non - Mentally Retarded] even if IQ were below 75. However, one could still not be declared to have MR [Mental Retardation] on the basis of adaptive skill level, no matter how great one's adaptive support needs might be."
>
> (Greenspan, 1999, p 11).

Thus, despite the aim of including a measure of adaptive functioning in order to improve the reliability of classifying learning disability, many have questioned whether this is actually achieved in practice. In effect, psychology services are at risk of 'gate keeping' when highlighting someone's suitability for access to services. For instance, someone with an IQ of 70 or above but still with intellectual deficit, as highlighted in the previous examples of Fragile X Syndrome and Autistic Spectrum Disorders, may be denied access to learning disability services, even though this may be the most appropriate service to suit their needs. Similarly, someone with an IQ of less than 70 may be denied access to mainstream services for co-morbid problems such as psychiatric disorder. Accordingly the BPS have highlighted that psychologists should be aware of this risk,

and that assessment should focus on "assessment of specific individual need," (BPS, 2001, p19). They also recommend that as a precaution, the confidence limit of a score on IQ should be reported. This is in recognition of the fact that any obtained score in a test is likely to only be an estimate of the true score, because every test is subject to some error (Powell, 1996), so that only if a test was 100% reliable would the standard error of measurement be zero. An IQ score should therefore be reported as the range of possible scores associated with the observed score and confidence level, (usually either 90% or 95%).

Nevertheless, even this means that at some point, an arbitrary cut off score is still used as an inclusion / exclusion criterion to a service, despite the "inadequacy of reducing a person to a single IQ number," (Accardo and Capute, 1998, p3). For example Dodd and Webb (1998) describe their use of the IQ test as an assessment of cognitive functioning for inclusion to their learning disability service, and while they still consider the possibility of standard errors, reluctantly conclude "in operational terms we decided that a person has an impairment of cognitive functioning if they have a full scale IQ below 70 on the WAIS-R," (Dodd and Webb, 1998). Furthermore, Evers and Hill (1999) state: "Many psychologists may be uncomfortable with the use of cognitive assessments. They may also be uncomfortable about devising systems for prioritising services," (Evers and Hills, 1999, p12). Here then is clear evidence that clinical psychologists are uncomfortable with the current practice of using the IQ test as a main method of diagnosing learning disability.

Validating the Concept of Learning Disability

As well as test reliability, another main requirement of any test is that of validity. For a test to be valid it must be able to measure the actual construct that it purports to measure (Powell, 1996). Including an assessment of adaptive behaviour was therefore viewed as essential to improving the validity of the classification, as well as reliability, because it was recognised that IQ assessment alone did not measure a person's ability to function. Using a social or adaptive measure broadened the construct of what a learning disability actually is, so making it easier to identify more reliably. Hence, the BPS holds that a formal assessment of adaptive / social functioning should be seen as good practice. However, the BPS also recognises that "the concept of adaptive / social functioning is very broad," (BPS, 2001, p5) and that some assessments only provide ways of describing characteristics, rather than measure actual behaviour or performance. Thus, the BPS is unable to recommend one particular test that purports to comprehensively assess adaptive / social behaviour, and a similar situation exists for the United States, (MacMillan, et al 1993). In fact, current constructs of social behaviour are criticised for having no conceptual basis for the skill areas defined as social behaviour, and for contributing little to the theoretical or clinical understanding of the nature of impairment, (MacMillan, et al 1993, p 329).

Global or Specific Impairment?

A major implication of the way that psychometric criteria has traditionally been used, may have led to a particularly invalid interpretation of the concept of learning disability. Some theorists

such as Detterman (1987) have claimed that Learning Disability is a single disorder that parallels normal intellectual development, but is globally delayed in some way. This has become known as the developmental or global delay hypothesis. Those people with delayed development are thought to make up two specific groups. One group corresponds to the BPS classification of significant impairment, with IQs ranging from 50 to 70, and the other group corresponds to those people with IQs below 50, who are classified as severely impaired (BPS, 2001).

The significantly impaired group make up the majority of all people with learning disability, and are often described as biologically intact, because their disability is thought to reflect their position at the lower end of the distribution of normal intellectual attributes. In a similar way to height, most people's intellect will fall relatively closely around the average, so that approximately 65% of all people will have a score of between one standard deviation below and one standard deviation above average. However, there will be a lesser amount of people whose intellect is either much higher, and those with much lower than average intellect, such as those people with a significant learning disability.

These people are therefore described as "non-organic" learning disabled, or "cultural-familial" learning disabled (Hooper, Boyd, Hynd and Rubin, 1993). The implication here is that whilst they have still genetically inherited their disability, they have similar intellectual attributes to those people in the normal range, but are merely globally delayed. Given the right environment and input, deficits in intellect may therefore be ameliorated (Hooper, et al, 1993). This population also constitutes the population of mild learning disabled that Plomin suggests have inherited intellectual deficit (Plomin, 1999). For instance he cites the study which showed that the risk of

retardation in a child is about 20% if one parent is mildly retarded, but rises to nearly 50% if both parents are retarded (Johnson, Adhern and Johnson, 1976). Plomin also concludes that mild learning disability appears to be at "the lower end of the distribution of the same genetic and environmental factors that affect individual differences throughout the normal variation." (Plomin, 1999, p35). Thus people with an IQ between 50 and 70 IQ points are interpreted as having non-organic learning disability, and are globally delayed.

People with IQs lower than 50, are described as a unique population. Global theorists recognise that this second subgroup seem to show their own unique distribution of intelligence level, independent of the normal distribution of intelligence (Hooper, et al, 1993). They are therefore thought to have 'organic' learning disability, and their disability often relates to specific organic dysfunction and atypical cognitive development (Bennett - Gates and Zigler, 1998). In such cases, specific aetiology is often known. Nevertheless, global theorists still maintain that people with organic learning disability are globally delayed. In fact, the assumption is that cognitive variables that make up intelligence tend to inter correlate even more highly, the lower the intellectual ability (Detterman, et al., 1992).

In contrast other theorists hold that learning disorder is marked by specific deficits in intellectual function. This means that people with learning disability are qualitatively and quantitatively different from the general population, and so the organic versus non-organic distinction is invalid (Ellis, 1969). Thus, earlier studies have found that people with learning disability have specific deficits in visual perception, rehearsal, attention, executive function, and verbal reasoning, in comparison to non learning disabled people (Bennett-Gates and Zigler,

1998). Nevertheless, the criticism here is that these specific impairments may be so numerous, that people with learning disability seem to have an 'everything deficit,' (Detterman, 1979). Hence, when compared to other people without learning disability they are inevitably impaired on just about all aspects of behaviour and function.

The study by Groff and Linden (1982) illustrates these points. They used the Revised edition of the Wechsler Intelligence Scale for Children (Wechsler, 1974) to assess the intellectual strengths and weaknesses of 'cultural-familial' mentally retarded children. They assessed one group of 'non-retarded' children with a mean chronological age of 9.5 years and mean WISC mental age of 9.5 years. This was compared with an 'older retarded,' group with matched WISC mental age of 9.5 years (chronological mean age of 15 years) and a 'younger retarded' group of children with matched chronological age of 9.5 years. The groups were not distinguished in any other way. Anyone with documented evidence of cerebral impairment, emotional disturbance, or institutional experience was excluded. Following the global or non-organic model of learning disability, their hypothesis was that there would be no difference in the *pattern* of WISC-R factor score profiles between the groups, because all children would have a similar developmental profile. The difference would only be in the degree of mental ability, so that while the mentally retarded groups would have lower overall scores, their actual pattern of function would be the same as the non-retarded group.

Verbal Comprehension, Perceptual Organisation and Freedom from Distractibility Factor profiles were analysed. Results indicated that as expected the non-retarded group showed average scaled scores of between 9 and 11 (10 is average and equivalent to 100 IQ points). The

older retarded group showed lower overall scores, ranging from 4 to 6 scaled scores, and the younger retarded group showed overall scores around 5 scaled score points. The authors interpreted this as evidence that there were no differences in the profiles measured, apart from the general expected difference in level of scores in the retarded groups. They stated "there was no evidence of differences in the intellectual strengths and weaknesses of cultural familial retarded and non retarded groups of equivalent CA [Chronological Age] or MA [Mental Age]." (Groff and Linden, 1982, p150).

However, on closer inspection of the data there actually is clear evidence of different profile scores. The younger retarded group showed no significant difference between the Performance and Verbal IQ scores, but there was a significant difference between these two profiles for both the non-retarded group ($t = -3.37$, $df\ 49$, $p < 0.001$) and the older retarded group ($t = -2.80$, $df\ 49$, $p < 0.005$), (Groff and Linden, 1982). In effect, the authors seemed to select the finding that the non-retarded children showed the same pattern as the older retarded group to fit their developmental hypothesis that non-organic mentally retarded are globally delayed. Similarly, they seemed to have rejected the finding that the younger and older mentally retarded group showed different profiles, interpreting these findings as evidence of "age related differences in the intellectual strengths and weaknesses of retarded youth," (Goff and Linden, p150). However, this seems inappropriate because without providing a mental age matched control of the younger non-retarded children, there can be no certainty that this conclusion can be reached.

The lack of validity in this subdivision between organic and non-organic learning disability is further demonstrated in recent advances in medical technology. It is now becoming possible to

identify an increasing number of causes of learning disability that have a medical basis, even though these may include genetic factors such as small chromosomal abnormalities and rare genetic syndromes, as well as biological factors such as prenatal and perinatal risks (Bregman and Hodapp, 1991). For instance Bregman and Hodapp report that in two recent studies that examined epidemiology in samples of Swedish and British children with mild learning disability and borderline intelligence, a medical risk factor such as perinatal trauma or genetic aetiology was thought to be responsible for the presence of impaired intellect in 30% to 42% of the 295 children, (Bregman and Hodapp, 1991). In addition, both parents of 39% of the children with a convincing medical cause for the disability, had had special education. Thus the authors state that if they had relied on family history, in keeping with the traditional viewpoint that mild learning disability would be expected in these children anyway, important medical causes would have been overlooked (Bregman and Hodapp, 1991).

The issue then, is not that children may inherit forms of mild learning disability, as this may clearly be the case. Instead, the issue is one of interpretation in that traditional views of learning disability suggest that *only* people with global or cultural-familial disability represent the lower end of the normal intellectual spectrum, and *only* people with organic disability represent those with IQ below 50. This cannot be a valid interpretation if a specific medical aetiology is discovered for people with IQ above 50. This artificial separation between non-organic versus organic, dependent on IQ of 50, is therefore redundant. As Pennington and Bennetto state, what is now needed is a theoretical framework that recognises that both global *and* specific cognitive processes are likely to be important (Pennington and Bennetto,1998), and that learning disability

should be conceptualised as "falling along a continuum of *impaired* neurological development," (Hooper, et al, 1993, p282) as opposed to a continuum of delay.

To summarise, current use of IQ tests and tests of adaptive behaviour are held to measure intellectual and practical intelligence respectively, and this is often interpreted as a sufficient analysis of a person's general ability (Brody, 1999). However, it has been demonstrated that the ways used to measure these two criteria in people with intellectual disability have questionable reliability, because the practice of classifying whether a person is or is not learning disabled rests on an arbitrary cut off score, that bears little relation to the actual phenomenon of learning disability. In terms of validity, the most recent attempts to improve the definition of learning disability by including a measure of adaptive functioning also does little to ameliorate to the problem. Furthermore, a potential misinterpretation that has arisen from the methodological and phenomenological issues associated with this classification has been the debate regarding global versus specific intellectual deficit. This assumption that mild learning disability is a global intellectual impairment forming part of the distribution of normal intelligence seems to underestimate the complexities of the construct. In the next section, further difficulties in the validity of the concept of learning disability will be demonstrated by comparing the current model of learning disability assessment with that of a neuropsychological approach to assessment of underlying cognitive impairment.

Section Two

Using neuropsychology to investigate the relationship between brain and behaviour

Comparing the use of psychometric tests in neuropsychology and learning disability

The origins of the IQ test were intimately tied to finding ways of linking intellectual behaviour with underlying brain structure. But with intelligence testing there was also an assumption that intelligence is attributable to a single unitary variable or 'g' factor, and in earlier studies, this meant that all cognitive activity was thought to be attributable to the single concept of intelligence (Lezak, 1995). However, whilst traditional methods of diagnosing people with learning disabilities have maintained the use of the IQ test, assessment methods used in neuropsychological practice have diverged and developed independently.

The Second World War helped give rise to this divergence, when in 1940 Hebb gave IQ tests to brain damaged people. He found that people with frontal lobe lesions sustained in combat, did not show decreased IQ scores, even though the frontal lobes at that time where thought to be the 'seat of intelligence' (Kolb and Wishaw, 1990). Furthermore, the area of damage did not necessarily have a direct relationship with the extent of behavioural change, so that it was possible to sustain a large area of brain damage and have less severe behavioural sequelae, or sustain a small area of brain damage, but have more severe behavioural sequelae.

Hence, "neuropsychological studies have demonstrated that there is no general cognitive or intellectual function, but rather many discrete ones that work together so smoothly when the brain is intact that cognition is experienced as a single seamless attribute." (Lezak, 1995, p23) Neuropsychological testing therefore borrows features of IQ testing in that individual tests are usually brief, objectively scored, and standardised using statistical procedures, (Kolb and Wishaw, 1990). The criteria for neuropsychological measurement of behaviour is also the same as in any scientific measurement in that it needs to be able to systematically define and measure observable behaviour changes following brain injury. However, "neuropsychology has contributed significantly to the redefinition of the nature of intelligence," (Lezak, 1995, p23), because any neuropsychological investigation into brain function would now include tests that purport to measure separate and dissociable domains of memory, attention, executive ability, spatial ability, visuoperceptual ability, somatosensory ability, language, and motor skills, in addition to general intellectual ability (Holmes-Bernstein, 2000).

Psychometric testing in neuropsychology has therefore diverged considerably from general IQ testing which still assumes that cognitive factors are not discrete but interrelated. Neuropsychological evidence suggests that functions such as perception, memory and executive function are not specifically delineated in current IQ tests such as the Wechsler Intelligence Scales (Lezak, 1995), and there is more to ability than that measured in an IQ test. A neuropsychological framework may therefore provide a more valid theoretical interpretation of what constitutes both ability *and* disability.

Neuropsychology and Diagnosis of Underlying Neurological Impairment

As well as a more valid theoretical understanding of learning disability, a neuropsychological approach may also provide a more valid clinical model. Miller (1992) highlights several goals to clinical neuropsychology assessment. For instance, he states that one goal is to diagnose underlying organic disease (Miller, 1992). This stems from an extensive history of attempts to link brain structure to brain function by localising function in a classical neuropsychological sense. Such classical studies include the unsuccessful search for the memory engram (as cited in Kolb and Wishaw, 1990) where Lashley systematically removed areas of cortex in animals to try and map specific memory traces to specific regions of the brain. Penfield's series of experiments mapping brain location to function provided a more systematic review of brain and behaviour (e.g. Penfield and Jasper, 1954, as cited in Kolb and Wishaw 1990), and more recently Goldman- Rakic (1993) have provided even more detailed analysis of brain and behaviour maps. Classic neuropsychology has therefore focussed on localizing functions of the brain and associated brain structures by empirically studying behaviour changes associated with brain damage.

Another main influence in neuropsychology has been the use of single case methodology, otherwise known as cognitive neuropsychology, and emphasises qualitative analysis. For instance case descriptions of Phineas Gage's altered behaviour following a penetrative frontal lobe injury led to the association between executive function and the frontal lobes (Harlow, 1868; as cited in Kolb and Wishaw, 1990). Studies by Broca and Wernicke into language function, demonstrated that left anterior and posterior lobes were associated with speech production and

speech comprehension respectively, following the study of people with lesions in these areas (Kolb and Wishaw, 1990). Furthermore the association between memory function and brain structure was highlighted in the famous case study of H.M. (Wilson 1965), where following bilateral removal of the hippocampus, this patient was left unable to store new long-term memories, despite having intact short term memory. Thus, systematic descriptions, associations, and dissociations of behaviour sequelae following brain damage has enabled powerful inferences to be made regarding cognitive structure and function (Shallice, 1988).

Taken together, both of these classic and cognitive neuropsychological approaches have been enormously informative, and are now being applied to learning disability.

Use of Scanning Technology in Learning Disability

For instance, scanning technology has been recently been applied to this area. For example, non-specific abnormalities such as smaller brain volume and dilated lateral ventricles have been associated with many idiopathic learning disabilities (Deb, 1997). Down Syndrome subjects have been found to have reduced volume in a variety of cortical and subcortical structures, with a disproportionately large reduction in the volume of frontal grey matter (Bigler, Nielsen, Wilde et al, 1999). In Fragile X syndrome, abnormalities in the temporal lobes, particularly the hippocampus, and reduced cerebellum size have been noted (Reiss, Freund, Tsan and Joshi, 1991). Structural abnormalities including localized parietal and frontal volume loss, and associated regional abnormalities in cerebral blood flow and metabolism have been reported in autism, (Bigler, et al, 1999). Bigler et al (1999) also report imaging studies into Angelman

Syndrome, Apert Syndrome, Friedreich Ataxia, Metabolic Disorder and Rett Syndrome. They conclude "most genetic disorders that influence the brain are associated with structural abnormalities that can be detected by standard neuroimaging techniques," (Bigler, et al, 1999). In addition, although they state that the relationship between structural abnormality and behavioural and cognitive deficits is not always a straightforward one, they feel that imaging techniques provide a crucial contribution for neuropsychologists as part of comprehensive evaluation and planned treatment.

Schaefer and Bodensteiner (1999) reiterate the inappropriateness of artificially separating organic from non-organic causes of learning disability. They add that the advancement of imaging techniques has enabled the identification of the "neuroanatomic correlates of neurodevelopmental abnormalities in a greater number of people than ever before," (Schafer and Bodensteiner, 1999, p54). Indeed it is estimated that Magnetic Resonance Imaging can now identify structural abnormalities in 34-98% of learning disabled patients in post-mortem studies, as opposed to standard neuroimaging techniques (e.g. Computer Axial Tomography), which identifies between 35-40%, (Schaefer and Bodedsteiner, 1999). It therefore seems apparent that valid clinical information can reveal more complex and heterogeneous changes associated with particular types of learning disability than classification by IQ alone.

There is thus a clear use for structural neuroimaging, in that it can further knowledge regarding the structural impairments in different types of learning disability. Using this approach and it's current technological developments may also lead to increasing awareness of previously unidentified causes of learning disability. Delineating specific causes can therefore provide useful

and valid information that may not be as readily available if learning disability is conceptualised as a global phenomenon.

Neuropsychological Testing in Learning Disability

With recent developments in neuroimaging, it may now seem redundant to use neuropsychological testing to diagnosing underlying impairment. However, scans are not always economically available, and more importantly, not all lesions are easily identifiable (Miller, 1992). They also provide little direct information of how an underlying impairment can translate into actual impaired behaviour. Psychometric testing using a neuropsychological approach however, can provide both diagnostic information, as well as a means of describing behavioural outcome (Lezak, 1995).

One area where neuropsychology testing already provides a clear role for diagnosis in learning disability, is in the diagnosis of Alzheimer's Disease in Down Syndrome. The phenomenon of dementia in Down Syndrome had provided a naturalistic example of the importance of delineating neuropsychological factors as opposed to just intelligence factors in this subtype of learning disability. With better medical and social intervention, people with Down Syndrome are now living longer, and some studies have estimated that nearly all persons with Down Syndrome who die over the age of 40 years show neuropathology associated with Alzheimer's Disease on post-mortem examination (Devenny, Silverman, Hill, et al., 1996). The pattern of behaviour change seen in dementing Down Syndrome people generally seems to parallel those behavioural changes in non learning disabled people with Alzheimer's Disease,

(Crayton and Oliver, 1993), including memory deficit, followed by problems with attention and abstract reasoning, language and then visuospatial abilities. As Alzheimer's Disease affects a wide range of functions, over and above general ability level, it has now been recommended that IQ tests be complemented with specific neuropsychological measures of attention, memory, language, motor co-ordination, constructional abilities, social functioning and behavioural skills in people with Down Syndrome, (Crayton and Oliver, 1993). This is particularly important, given that

> "persons with Down Syndrome who develop Alzheimer's Disease usually maintain personal integrity by continuing to perform routine tasks and to converse socially at a relatively superficial level. Even if difficulties in functioning become apparent, they may be incorrectly attributed to the underlying mental retardation rather than to the developing dementia," (Crayton and Oliver, 1993, p138).

Thus an additional disability may be masked if the person already has a pre-existing disability, and so they may miss out on opportunities for treatment.

There is now increasing recognition of the need to use neuropsychological tests as opposed to intelligence tests, to effectively diagnose Alzheimer's Disease in Down Syndrome. For example Hon, Huppert, Holland and Watson (1999) advocate the use of the Cambridge Cognitive Examination (CAMCOG), a battery of neuropsychological tests taken from the Cambridge Examination for Mental Disorders of the Elderly (CAMDEX, Huppert, Brane, Gill, Paykel and Beardsall, 1995), because educational tests "do not cover fully the required range of cognitive abilities," (Hon, et al, 1999, p 157). In addition, Alzheimer's Disease is a late onset

condition, which in non-learning disabled adults is not necessarily thought to be an inevitable stage of development. Nevertheless, because there is such a high prevalence rate of Alzheimer's Disease in Down Syndrome, some researchers believe that it is intimately linked to the underlying genetic condition. So, whether Alzheimer's Dementia is an acquired disease, or evidence of a late onset developmental expression, there seems to be strong case for delineating the changing underlying impairments in Down Syndrome, throughout development. Indeed, recent clinical guidelines regarding the necessity for neuropsychological assessment and clinical management of people with Down Syndrome and dementia have now been recommended (Janicki, Heller, Seltzer, et al., 1996; Aylward, Burt, Thorpe, et al., 1997)

Research also suggests that people with Down Syndrome have specific memory deficits, over and above general intellectual ability, throughout their lifespan. For example, McDade and Adler (1980) compared a group of Down Syndrome subjects with a group of chronological age matched controls, and a mental age matched control group. Subjects were asked to recall items from a previously seen or heard list. Results indicated that Down Syndrome subjects were able to encode a similar amount of auditory information in comparison to the other learning disabled group, but were more impaired in the free recall of this information. This implied that both of these groups could store auditory information equally as well, but that the Down Syndrome subjects had a particular difficulty in retrieving this information. In addition, Down Syndrome subjects also had a particular difficulty in storage and retrieval of visual information, in comparison to the other learning disabled group, and that this impairment was even more severe than for auditorily presented material.

Other examples of studies into memory impairment in Down Syndrome include the study by Vicari, Carlesimo and Caltagirone (1995) who compared the ability of Down Syndrome subjects, subjects with learning disability of mixed aetiology, and chronological aged matched controls, in short term and working memory tasks. They found that there was no difference in auditory or spatial short-term memory span, so that all subjects were able to maintain a similar amount of information in the short term. This was felt to demonstrate relatively intact serial processing of incoming information. However, when subjects were required to reverse the sequence of information, subjects with Down Syndrome were found to have a much greater difficulty. Reversing a just heard series of digits is thought to be harder because it requires the rehearsal or maintenance of the string of items, *as **well*** as their simultaneous reproduction in reversed sequence. Thus working memory, or the ability to maintain and simultaneously process information, requires more cognitive ability, and may be a selective impairment in Down Syndrome. Auditory working memory deficit in people with Downs Syndrome has also been confirmed by Hulme and MacKenzie (1992). They argue that these working memory difficulties arise from more general language deficits, but in turn lead to compromises in the acquisition and performance of other skills. Carlesimo, Marotta and Vicari (1997), also confirmed that Down Syndrome subjects had a particular difficulty in actively retrieving stored information, and in using organisational strategies such as semantic clustering which normally improves episodic memory, when compared to a group of similar chronological aged subjects with unspecified learning disability.

These studies provide some evidence for the importance of delineating the specific cognitive function of memory, over and above general intellectual ability. Comparing the

performance of a group with a specific learning disability with a group of learning disabled people of mixed aetiology, enabled the identification of specific memory deficits in the Down Syndrome group. In this way, Vicari et al (1995) argue that "intellectual disability is not a uniform condition, characterised by undifferentiated delay of cognitive development, but rather, that it is characterised by a deficit of a complex cognitive system in which some cognitive abilities can be disrupted more than others," (Vicari, et al, 1995, p 536). Furthermore "neuropsychological studies can provide valuable information about the qualitative features of an intellectual deficit in relation to the normal population and to different aetiology ID [Intellectual Deficit] groups." (Vicari, et al 1995, p536) A neuropsychological framework therefore seems to provide an important way of diagnosing specific memory impairment in Down Syndrome, and could also be applicable to other types of learning disability as well to other cognitive domains.

For example, Sabbadini, Bonanni, Calesimo and Caltagirone (2001) undertook neuropsychological assessment of a group of eight patients with cerebral palsy (aged range 9 to 30), commenting that until then, no thorough cognitive evaluation of this type of population had ever been done. The battery of neuropsychological tests required adaptation because of the severe neuromotor disability and communication problems experienced by these patients, but results indicated comparable performance in tests of basic linguistic abilities such as phonological, phonemic, lexical and semantic abilities, when the patients were compared to an age matched control group. However, they were more impaired in the ability to recognise grammatical structure. Sabbadini et al (2001) felt that this was mainly because of impaired working memory, required here in the processing of information such as word order, and subject and verb relationships, found in more complex language processing. The authors also found that patients

with cerebral palsy had comparable short-term memory function, but were more impaired in a long-term memory task, indicating a reduced storage or retrieval ability. Finally, the patient group were much more impaired in all tests that measured visuo-perceptual and spatial stimuli.

Moreover, when individual cognitive profiles were analysed separately, it was found that some patients showed a homogenous pattern of cognitive deficit, so that they had a similar level of ability across all domains tested. However, three out of eight showed a much more heterogeneous profile, where performances on some tests were particularly impaired, with two being particularly deficient in perceptual and visuo-spatial abilities, and one having particular difficulty in verbal memory. The authors argue that using a comprehensive neuropsychological approach meant that specific abilities and disabilities could therefore be identified, and the finding regarding impaired perceptual efficiency and visuo-spatial reasoning was particularly important, "as there is no current experimental work in this area," (Sabbadini, et al, 2001, p 178). A neuropsychological framework could therefore contribute important diagnostic information about cerebral palsy because specific deficits were highlighted with this disorder over and above global impairment.

People with Autism have perhaps received the most attention regarding neuropsychological function. In a review of neuropsychological studies, Hooper et al., (1993) state that a consistent finding is that of disturbed language ability. This language impairment specifically includes severe comprehension deficit, deficient symbolic-representation abilities, impoverished verbal mediation and gestural communication, and heightened presence of neologisms and idiosyncratic language (Hooper, et al 1993). This contrasts with better visual-

perceptual abilities (Hooper et al, 1993). In addition, Happé (1998) reports that people with Autism tend to be better at resisting certain visual illusions in comparison to controls, and interpreted this as evidence of fragmented visual perception, with a difficulty in integrating visual information (Happé, 1996). There has also been a wide range of research into 'thoery of mind' deficit, or the difficulty that autistic people seem to have in representing the mental states of others (e.g. Baron-Cohen, Tager-Flusberg, Cohen 1993). This is thought to underlie social difficulties such as failure to understand deception.

There is therefore an emerging literature on the neuropsychological correlates of a range of learning disabilities. Applying a neuropsychological framework to conditions such as Down Syndrome, Cerebral Palsy and Autism provides useful diagnostic information about specific areas of cognitive impairment, as opposed to the assumption that these conditions are simply marked by global impairment. Whilst some adaptations of standard tests may be required in order to overcome physical and perceptual difficulties and avoid floor effects where tests may be too hard, a neuropsychological framework has been successfully used in many of the cited examples, and has contributed valuable information about learning disability. Thus, "a thorough neuropsychological evaluation could provide a specific analysis of the motoric, perceptual, mnestic, and other cognitive functions of individuals with mental retardation," (Hooper, et al, 1993, p284), and a brain and behaviour framework may provide a useful theoretical and clinical model of learning disability.

Integrating Neuropsychological and Traditional Assessment Methods

Despite a clear case for using more comprehensive neuropsychological assessment, attempts have been made to reduce complex cognitive function to more basic cognitive abilities, and argued that they can be predicted from IQ. For example, Detterman, Mayer, Caruso, Legree, Conners, and Taylor (1992), used multiple regression analysis to investigate the relationship between memory, reaction time, perception and IQ, in 20 subjects with mental retardation (mean WAIS Full scale IQ = 67.45, standard deviation = 7.56), and 20 college students (mean WAIS IQ = 115.55, standard deviation = 7.79). They reported that the multiple correlation between variables for the mentally retarded group was R = 0.9; R = 0.76 for the non-mentally retarded group; and the combined multiple correlation was R = 0.92. From this they concluded that "basic cognitive tests correlate with intelligence test as well as different intelligence tests correlate with each other," (Detterman et al, 1992, p 276), and were left in no doubt that "if the processes taking place in these basic cognitive tasks were understood, we would also understand intelligence." (Detterman, et al, 1992, p276)

Nevertheless, on closer inspection of the data, they show that they may have been wrong in their first assumption that all of the cognitive variables in their study were highly related. This is particularly demonstrated with the memory task. Here, subjects were shown eight symbols, each shown for one second, in random order, in a horizontal array of eight squares. Subjects were then shown a stimulus probe, containing one of the symbols, and the subjects had to touch the square that the original stimulus had been in. A second stimulus probes was then shown, and so

on until all eight symbols had been shown. They repeated this procedure until a criterion of one perfect trial, or 40 trials, had been completed.

When performance on this task was analysed, it was apparent that the college students were able to achieve a perfect score within an average of 8.69 trials, with standard deviation of 5.25. On the other hand, the mentally retarded group took an average of 34.53 trials, with standard deviation of 10.77, to reach perfect score. This meant that most of the mentally retarded group took many more trials to complete the task successfully. Moreover, with such variability, it must have meant that some never reached a perfect trial at all, and so effectively were unable to do the task.

Detterman et al., (1992) argued that for mentally retarded people, underlying cognitive abilities were even more inter-related than with non-retarded people, thus supporting a global impairment hypothesis. However, if the subjects were particularly poor at the task, it cannot be assumed that this shows a true reflection of their memory performance. As Sternberg suggests "correlations may be higher for the students with mental retardation because some of them simply did not understand the task," (Sternberg, 1992, p293), and this would also be consistent with the high variances noted in all of the chosen variables. The authors may therefore be wrong to assume that poor task performance equates with global delay, and it actually shows support that learning disabled people may have specific memory deficits which are masked when subjects are grouped together.

A second assumption made was in the types of tasks they felt reflected the psychological construct they purported to measure. The above memory task was not a standard memory task in that it would have been difficult to exclusively assess the basic memory processes of storage, rehearsal and retrieval. Instead it was a task that involved a combination of abilities, as well as the storage and recall of atypical visuospatial information. For instance, a person would have to be able to store eight symbols, as well as remember which spatial position they had previously seen these in, and which of the spatial positions they had already identified. This task would therefore likely require extensive ongoing working memory. Thus, perhaps it may have been a specific impairment in *executive function* that predicted IQ ability, rather than memory per se. In sum, the likely cognitive effort required to complete this task suggested that it was not a basic cognitive task after all.

Again this shows that it is extremely important to delineate separate cognitive domain functions, which is now increasingly possible with current neuropsychological methods. If a person is more impaired in memory for instance, this specific impairment is likely to affect their ability to remember task instructions. Similarly, if they are specifically impaired in language processing, then tasks that are language based may cause particular difficulty and potentially contaminate results in other domains. Finally, if a person has difficulty focussing or switching attention, then this is also likely to have a significant impact on task performance.

To sum up, grouping together people with a wide range of causes of disability into one classification, and implying that the construct of learning disability is global, leads to problems of validity, when emerging neuropsychological evidence shows that often, particular types of learning

disability have particular profiles of specific deficits. Grouping people in this way may also mask important relative strengths and weaknesses, so that some skills may be underestimated, and some overestimated. This has special implications for dealing with individual clinical assessment, when it is important to establish what an individual's clinical psychological needs are likely to be. It also has particular significance at a managerial level when determining the suitability of service provision. The decision to select an individual for learning disability service provision is probably clear in cases where there is well known aetiology such as Down Syndrome. However there may be a real risk that people will be rejected if their intellectual function lies above the designated cut off point, especially if their aetiology is unknown. These people may therefore have their needs unmet.

This seems to have particular relevance to the assessment of children with learning disability, because of the development of emerging cognitive skills. Thus, more accurate assessment of a child's strengths and weaknesses would perhaps enable more effective intervention and habilitation. Subsequently, the following section explores the particular importance of applying a brain and behaviour approach to children with learning disability.

Section Three

Assessing the Needs of Children with Learning Disability

The Importance of Early Intervention

In clinical neuropsychological assessment, another stated goal has been "in an important sense, to produce a comfortable, competent 25 year old – that is, an adult who can take his or her place in society." (Holmes-Bernstein, 2000, p408) This statement alludes to the importance of clinical intervention with children who have acquired cognitive impairment, such as traumatic brain injury, in recognition that brain damage sustained in childhood occurs in the context of a developing brain. To extrapolate, whatever the cause of learning disability, it must also has a bearing on the developing brain. For example, there is a robust finding that the rate of intellectual development seems to decline in the first few years of life in people with Down Syndrome (Ludlow and Allen, 1979). A Down Syndrome child's score on an IQ test can often be just below the normal range when in infancy, but may decrease to the moderate to severe range of ability by school age (Wishart, 1996). This means that new skills are developing at a slower rate when compared to children without learning disability, and also at a slower rate when compared to the individual child's previous ability. Identifying cognitive strengths and weaknesses within the

developing brain could therefore be potentially clinically useful, as it may provide a framework for remediation (Temple, 1997).

Indeed, there have been many early intervention programmes that aim to support the development of cognitive skills in children with learning disability. However these have had limited success, and Wishart argues that it is precisely because they assume that children show global developmental delay, rather than acknowledge specific skill deficit (Wishart, 1996). Consequently, rather than adapt education techniques in recognition of specific deficits such as lack of motivation, or atypical sequences in skill development, current teaching makes only basic changes to teaching methods used for normally developing children. In sum, identifying the impediments to learning in individual children is crucial for the advancement of strategies that would effectively support learning, (Stanley and Dolby, 1999). This thesis will therefore focus on applying a neuropsychological, or brain and behaviour, approach to children with learning disability, because of the clinical importance of being able to delineate cognitive strengths and weaknesses at an early age.

Needs assessment

An additional advantage to focussing on children in the current study has been the opportunity to conduct a clinical needs assessment for a new clinical learning disability team. There has been particularly poor provision of clinical services for children with learning disability in Scotland, recently highlighted by the Scottish Executive (Same as You?, 2000). In the author's particular health region, community learning disability nurses were the only clinical health workers

with this specific remit. Within the last few months however, the development of a multi-disciplinary learning disability team has been initiated, and a Consultant Paediatric Psychiatrist and Consultant Clinical Psychologist have been appointed. This thesis therefore provides a naturalistic opportunity to investigate the clinical needs of children with learning disability. Stevens and Raftery (1997) state that the main purpose for a health care needs assessment is to ensure that they lead to beneficial intervention. Moreover, determining this depends on describing the incidence and / or prevalence of a problem, as well as determining the effectiveness of the interventions available to manage the problem (Stevens and Raftery, 1997). By using a more reliable and valid neuropsychological approach, as opposed to more traditional IQ assessment, it may therefore be possible to better assess the true nature and prevalence of cognitive impairment.

Executive Problems or Emotional Difficulty?

An additional remit for the needs assessment was the identification of psychological or psychiatric disorder. This is in recognition that people with learning disability may be more vulnerable to psychological distress, which is often shown as challenging behaviour (Baker, La Vigna and Willis, 1998; Clements, 1992). However, this is entirely in keeping with a full and comprehensive neuropsychological assessment, as Holmes-Bernstein neatly summarises in the following way:

> "This entails both an intra-individual and a broad based analysis, encompassing in one integrated assessment emotional, regulatory, motor, and sensory capacities, as well as cognitive abilities and social, societal, and academic achievement. These requirements

> dovetail perfectly with the neuropsychological perspective on behaviour. Not only does clinical neuropsychology by its very nature as a clinical discipline focus on the individual; it is also inherently integrative in its fundamental reliance on knowledge of the brain as the necessary, albeit not sufficient, substrate for *all* behaviour."
>
> (Holmes-Bernstein, 2000, p408)

This link between cognitive ability and other behaviours that might influence overall function may be a particularly important one in understanding learning disability. For instance, in learning disabled people, the prevalence of psychopathology is correlated with degree of intellectual impairment (Bregman, 1991), and between one-third and two-thirds of individuals with learning disability in community samples have been found to exhibit psychopathology (Bregman, 1991). This suggests that they are at a heightened risk of emotional and behavioural disorders. While there is no doubt that people with learning disability may often be exposed to negative experiences, in an environment that can be indifferent, disdainful or hostile, (Berg and Gosse, 1990), these raised prevalence rates for psychopathology may indicate an underlying neurological vulnerability, as well as psychosocial influence. Thus a complex biopsychosocial interaction may combine "in intricate and not easily discernable ways, to produce adverse behavioural effects and reactions," (Berg and Gosse, 1990, p53).

However, due to communicative and cognitive difficulties, the assessment of psychopathology in people with learning disability is difficult. Traditional methods have focussed on the systematic analysis of the frequency, duration and severity of observable behaviour such as time series methodology and functional assessment. More recently, behavioural checklists,

such as the Child Behaviour Checklist (Achenbach, 1991), have provided informant based assessment scales, but have not been specifically standardised for people with learning disability (Bregman, 1991). Hence, there is a risk that emotional and behavioural problems may be confused with cognitive difficulties, and vice versa. For instance, there is often confusion regarding challenging behaviour as to whether it indicates mental illness or not, leading to problems in differential diagnosis (Caine and Hatton, 1998).

One reason for this potential confusion may be because some of the types of behaviour difficulties most associated with learning disability could also reflect executive dysfunction. Executive function enables a person to "engage successfully in independent, purposive, self-serving behaviour," (Lezak, 1995, p42). Specific tasks such as approaching, planning, carrying out and monitoring tasks, may be affected with executive dysfunction, as well as the ability to shift focus of attention, and to be cognitively flexible. As previously mentioned, working memory, is considered an example of executive ability because this reflects the ability to hold a goal in mind whilst engaging in the plan to reach that goal (Middleton, 2001). However, executive dysfunction can also manifest in more general behavioural terms such as difficulties in self-control, which may lead to emotional lability *or* emotional flattening, irritability, and impulsivity (Lezak, 1995). Thus, investigating the link between executive dysfunction and behavioural difficulties seems an important additional goal of the current study, because of the importance of accurately defining underlying impairment, and how it translates into observable behaviour. This might therefore assist in the differential diagnosis of functional versus organic behaviour problems.

To summarise, there were two main reasons for focussing on children with learning disability in the current study. Firstly, highlighting the cognitive and behavioural strengths and weaknesses in individual children may enable more effective intervention, as early habilitative support may facilitate skill development. Secondly, there was a specific clinical remit to provide an assessment of needs for a new child learning disability service. This included identifying cognitive as well as emotional problems, and to investigate the link between them.

Rationale

The use of developmentally related performance is one of the key methods of highlighting whether learning disability is a marked by a global developmental delay or specific cognitive deficits. In the previous study by Groff and Linden (1982), a group of non-mentally retarded children were matched with a group of chronologically older (mentally retarded) children with similar mental age, and a group of chronologically similar aged, mentally retarded children. This paradigm is often used by global developmental theorists, because if mentally retarded and non-mentally retarded individuals of a given mental age show similar cognitive function, then it would be possible to interpret this as evidence that they show similar cognitive development, (albeit the mentally retarded group would be delayed). Deficit theorists on the other hand try to identify differences in retarded and non-retarded individuals of a similar chronological age. As previously suggested however, these two paradigms can be used selectively to support either the developmental or the difference debate. As Chapman and Hesketh state, "comparisons to chronologically age matched children, of course, simply confirm delays in learning," and mental

age matching "depends critically on the skills included, including the content and number of items of different developmental levels, (Chapman, and Hesketh, 2000, p85).

To overcome this methodological problem, the current study therefore used one sample of children with mixed causes of learning disability, but assessed each individual child's ability on a comprehensive range of neuropsychological and behaviour function. In this way, a child's relative strengths and weaknesses could be assessed, relative to their overall IQ measure. This would provide a robust method of investigating whether learning disability was marked by specific cognitive deficit, as it was expected to give rise to a profile of dissociable cognitive and behaviour strengths and weaknesses. Alternatively, if learning disability was marked by a global developmental delay, there would be a substantial inter- correlation between IQ, neuropsychological and behavioural function, rather than a profile of scores. As far as it is known, this use of comprehensive assessment to investigate the nature of learning disability in this way has not been conducted before.

To this end, twenty three children with learning disability were comprehensively assessed for IQ, neuropsychological and behavioural function. The children attended a local special education school, and were approximately aged between seven and fourteen. As there are no comprehensive IQ tests specifically standardised for use with learning disabled people, the WISC-III-UK, (Wechsler, 1992) was chosen to assess IQ because it is considered to be the 'gold standard' intellectual assessment (Spreen and Strauss, 1998).

Performance on this IQ test was then compared with the NEPSY neuropsychological battery (Korkman, Kirk and Kemp, 1997). It consists of a series of neuropsychological tests separated into five cognitive domains of attention and executive function; language; sensorimotor function; visuospatial processing; and memory and learning. It was expected that IQ would not be significantly associated with attention and executive function, sensorimotor function, visuospatial processing, or memory and learning. However it was felt that IQ and language function would be associated, because it is well known that language mediates many cognitive processes, (Lezak, 1995, Spreen and Strauss, 1998). This battery was favoured over other neuropsychological tests because it provides a comprehensive neuropsychological assessment, based on well established neuropsychological principles (Kaplan, 1998). For instance, it enables the evaluation of the way that emerging skills in one functional domain can affect the development of skills in other domains (Korkman, et al, 1998). Other considered scales included the Kaufman – ABC Battery (Kaufman and Kaufman, 1983). However, the K-ABC was not thought as appropriate because it analyses performance along a right hemisphere (gestalt-holistic-simultaneous) versus left hemisphere (analytic-sequential) dimension. This was felt to be unwieldy, and lacked face validity, whilst face validity for the choice of functional domains in the NEPSY seemed better. Furthermore, the NEPSY was particularly useful for estimating executive function, for comparison with behaviour and emotional function.

Behavioural assessment was achieved using the Developmental Behaviour Checklist (DBC) (Einfeld, Tonge, and Parmenter, 1992; Einfeld and Tonge, 1992). This is a 94 item informant questionnaire, designed to assess a broad range of behavioural and emotional disturbance in children and adolescents with learning disability. Two versions exist: the Teacher

Version and the Primary Carer version. The Teacher version was used in the current study, for practical reasons, as it enabled all data collection to take place at school. This was still felt to be appropriate however, because it would still provide influences such as complex social demands, which can provide useful and valid contexts for assessment. The scale further subdivides into disruptive, self-absorbed, communication disturbance, anxiety, social relating and antisocial behaviour domains.

For the current study it was felt that disruptive and self-absorbed behaviour disturbance would most likely relate to executive function. The disruptive behaviour domain included items such as 'becomes over-excited,' 'mood changes rapidly for no apparent reason,' and 'impulsive, acts before thinking.' These items were felt to be similar to the types of problems that can arise from executive dysfunction that involve behaviour dysregulation, such as impulsivity, and monitoring difficulties. The self-absorbed behaviour domain included items such as 'preoccupation with trivial items,' 'repetitive actions,' and 'wanders aimlessly.' This domain was thought indicative of problems with initiation, switching attention, and goal directed activity, also associated with executive dysfunction.

The Child Behaviour Checklist (Achenbach, 1991) was the other main behavioural instrument that was considered. However, this was not specifically designed for use with learning disabled people, unlike the DBC. Furthermore a recent study revealed poor test reliability when used with this population (Embregts, 2000).

Summary of Rationale

The main hypothesis of the study then, was to evaluate whether a neuropsychological approach would provide a better theoretical and clinical account of learning disability than traditional methods, because it looks at a wider range of cognitive variables over and above those tapped by a general assessment of intellect. This contradicts the assumption that all cognitive ability is interrelated, and measurable as a 'g' factor, and that people with lower than average IQ are globally delayed. An additional hypothesis was that some of the behaviour difficulties often associated with learning disability may reflect underlying executive impairment. Applying a brain and behaviour framework to the assessment of children with learning disability would therefore help to inform the debate on the global versus specific hypothesis of learning disability, and perhaps provide a more reliable and valid assessment of the needs of children with learning disability.

HYPOTHESIS ONE

This thesis argues that a brain and behaviour framework will provide a better account of learning disability because it enables the identification of a wide range of cognitive strengths and weaknesses. This assumption is based on the argument that learning disability is characterised by specific cognitive impairments, as opposed to a global developmental delay. Thus, there will be no significant association between IQ, as measured with the WISC-III-UK and neuropsychological function measured using the NEPSY, (Korkman, et, al., 1998). This leads to the following specific hypotheses:

1a) There will be no significant correlation between IQ and attention and executive function.

1b) There will be no significant correlation between IQ and sensorimotor function.

1c) There will be no significant correlation between IQ and visuospatial function.

1d) There will be no significant correlation between IQ and memory.

1e) In contrast, there will be a significant positive correlation between IQ and language function because language is thought to mediate many cognitive processes.

HYPOTHESIS TWO

The second hypothesis predicts that executive dysfunction might lead to the types of behaviour problems experienced by people with learning disability, because they are directly related cognitive constructs. Specifically:

2a) There will be a significant negative correlation between scores for attention and executive function measured using the NEPSY, and Total Behaviour Problem Scores, measured using the Developmental Behaviour Checklist.

2b) There will be a significant negative correlation between attention and executive function measured using the NEPSY, and disruptive behaviour scores, measured using the Developmental Behaviour Checklist.

2c) There will be a significant negative correlation between attention and executive function measured using the NEPSY, and self-absorbed behaviour, measured using the Developmental Behaviour Checklist.

2d) There will be no significant correlations between scores for the remaining neuropsychological domains and behaviour problems because these functions are not directly related with one another. Thus sensorimotor function, visuospatial function, memory and learning, and language function, measured using the NEPSY, will not correlate with Total Behaviour Scores on the Developmental Behaviour Checklist.

METHOD

Participants

An attempt was made to recruit a whole cohort of primary school children from a local special school. This type of sampling is referred to as purposive sampling (Clark-Carter, 1997), where there is an opportunity to sample a clearly defined group, representative of the whole population of learning disabled children. This would have several methodological advantages. Firstly, assessing the whole cohort would preclude the need for a randomised sample. This would increase the reliability and generalisability of the findings, because they would not need to be extrapolated. Secondly, using a whole cohort from one school would mean that it would be representative of other similar cohorts in other special schools.

Through discussion with the Consultant Paediatric Psychiatrist for Learning Disability, a particular school was chosen because it served a mixed population of rural and urban geographies, and was close to a major city. It was therefore felt to represent people from a wide range of socio-economic backgrounds, and was likely to be a good representation of other special schools. These advantages would also be useful for fulfilling the remit of the needs assessment, as it would provide a representative sample of the prevalence of neuropsychological and

emotional factors for the whole health district. Accordingly there were no inclusion or exclusion criteria for selection.

A total number of 53 children, aged between six and thirteen years, were available for recruitment to the study. All of the childrens parents and guardians were approached by letter. This provided information regarding the nature and purpose of the study, and a consent form for agreeing to their child's participation. Copies of these are available in Appendix 1. A stamped addressed envelope was also provided for parents to return the consent form. Parents were also given the opportunity to receive a report on the results of the assessment on their child, as well as an opportunity to meet with the main researcher to discuss findings.

A total of 24 consent forms were returned. It was assumed that the majority of those who did not respond had elected not to participate. Given that a small number of parents in this population may have had literacy difficulties, there may have been some parents who were unable to consent. This number was expected to be very small however. In addition, there may have been some bias in the remaining sample, if particular parents were more likely to respond than others. Nevertheless, whilst the return rate was relatively low, it was felt that this still provided an adequate representative sample of approximately half of all available participants. One of the 24 participants accepted for the study, was also later excluded as he was expelled from the school. This meant that a total of 23 children participated in the study.

Age of Participants

Participant's ages ranged from 7 years 6 months to 14 years 10 months. Mean age was 11 years and 11 months, with standard deviation of 21 months. There were fifteen boys and eight girls. This ratio of 1.88:1 is slightly higher for males, than other prevalence studies (Hatton, 1998).

Characteristics of Participants

When describing further characteristics of the participants, it was important to preserve anonymity. Thus, only brief descriptions of these characteristics are given. In addition, some of the children experienced more than one of the following: In terms of known aetiology, three children had mothers who had experienced ongoing difficulties in pregnancy; five children were born prematurely; and five children sustained birth trauma or had difficulties in the perinatal period. Four children were found to have cerebral insults. Three children were found to have chromosomal disorders. Other conditions included autism and metabolic disorders. Four children had co-morbid epilepsy, and one child had a co-morbid neurological syndrome. Several children either had, or were suspected of having ADHD. Eleven of the children seemed not to have received any formal diagnosis relating to the cause of their disability, although in reviewing the case notes many of these children had possible prenatal, perinatal, or familial reasons for their learning disability. Five of these children however, had no identifiable cause.

Medication

Seven children were prescribed psychoactive medication. These included Sodium Valporate; Carbamazapine; Lamotrigine; Clobazam; Flixotide; Methylphenidate; Melatonin; and Thyroxine. Some of these drugs, such as anti-convulsants may adversely effect cognitive functioning, whereas others such as Methylphenidate may facilitate cognitive performance. However, given that people with learning disability have a heightened prevalence for co-morbid conditions which require medication, (Hatton, 1998) it would be impractical to exclude such participants.

Sensory Impairments

Seven children had hearing difficulties, however these were usually mild difficulties and untreated. Nine children had visual difficulties, all requiring glasses. Some of the visual difficulties were related to long or short sight, and several children had known visuoperceptual problems. When assessing these children, consideration was therefore given to their additional sensory needs.

Social characteristics

As previously highlighted, it was thought that this particular special school that the participants attended, would provide a representative sample of rural and urban dwellers, as well as a mixture of social class background. Thorough investigation of these particular characteristics

was beyond the remit of the current study. All children however either lived at home with parents or guardians.

Design

Designing a Suitable Control

Whilst the use of a comparative group of similar aged children with normal intellectual ability is often seen as a more appropriate method of control, and is often used by theorists who hold that children with learning disability have specific differences in their abilities, this method only serves to show that children with learning disability perform worse than children without learning disability (Chapman and Hesketh, 2000). As previously highlighted, using chronological age matched controls in this way selectively and invalidly supports the hypothesis that children with learning disability are different from children without learning disability, without providing a means to refute this. A more robust design would demonstrate that the same children show different patterns of behaviour under different conditions. This would also enable better control of intra-individual factors such as motivation. For this reason, a within subjects design using one experimental sample was adopted.

This design would also preclude the need for a mental age matched control group. This method of control is often used by global developmental theorists, in order to demonstrate

similarities between children of the same mental ability, irrespective of age. Again, such findings selectively support the developmental hypothesis, without providing a way of refuting the findings. However, if the same learning disabled children served as their own control, and were found to show no difference in performance across different conditions, then it would be possible to state that their impairment was global.

Independent Variables

IQ, assessed using the WISC-III-UK (Wechsler, 1992), was considered as one independent variable. This also served as the control condition, against which the effects of the other independent variables of neuropsychological function were compared. Neuropsychological function was measured using the NEPSY neuropsychological battery (Korkman, et al., 1998). This consisted of five separate conditions corresponding to the NEPSY core domains of attention and executive function; sensorimotor function; visuo-spatial processing function; memory and learning; and language function. Behavioural and emotional function was measured by the Developmental Behaviour Checklist (Einfeld, et al., 1992). This consisted of six conditions corresponding to the separate dimensions of disruptive behaviour; self-absorbed behaviour; communication disturbance; anxiety; social relating and antisocial behaviour, as well as a seventh dimension of total behaviour problems score. Scores achieved in all of these separate conditions represented the dependent variables.

Pilot Testing

The assessment measures used in the study have been widely used in psychology research, and so piloting the particular design was felt unnecessary. However, as part of the remit was to provide a needs assessment for the clinical learning disability service, the study was considered to be a large scale pilot study in itself, for finding more effective ways of assessing the clinical needs of children with learning disability.

Materials

IQ Assessment

Test Description

The WISC-III-UK, (Wechsler, 1992) was used to assess the participants intellectual ability (IQ). This test is often considered the gold standard in intelligence testing and is one of the most widely used psychometric tests (Spreen and Strauss, 1998). Whilst there are concerns regarding the use of the WISC-III-UK with people with particularly low IQ, (BPS, 2001), using this scale was considered particularly useful in demonstrating the main themes of this study, which were to highlight the problems with reliability and validity of the IQ test itself. As the WISC-III-UK is a widely established test battery, further details regarding test characteristics and psychometric properties are summarised in Appendix 2, and are also available in the appropriate manual (Wechsler, 1992).

Neuropsychological Assessment

Test Description

The NEPSY (Korkman, et al 1998) is a recently published test battery, based on well established neuropsychological principles (Kaplan, 1998). An overall aim of the development of the battery was to provide a comprehensive assessment of a wide range of cognitive domains, in order to evaluate the way that emerging skills in one functional domain can affect the development of competencies in other domains (Korkmann, et al, 1998). This would therefore enable the identification of primary neuropsychological deficits, and secondary deficits that may arise as a consequence. Four other aims underpinned the development of the battery. These were to create a reliable and valid measure of factors that can interfere with learning; to contribute to the understanding of congenital and acquired brain injury; to enable long-term follow up because many cognitive disorders change as a function of age; and to contribute to the understanding of normal and atypical neuropsychological development (Korkman, et al, 1998).

The NEPSY covers an age range of 3 years 0 months to 12 years 11 months. It consists of a series of neuropsychological subtests, separated into five functional domains, of attention and executive function; sensorimotor function; visuospatial processing; memory and learning; and language. Within each domain there are core subtest and expanded subtests. All of the core tests from the five domains can be used together to provide an overview of a child's neuropsychological function. The additional expanded tests can also be added for more thorough

analysis. There are standardised normative values to compare the performance profile of an individual child, to assess relative cognitive strengths and weaknesses within and across the five domains. There are also norms available from several clinical groups, including children with ADHD, with or without specific learning difficulty; reading difficulty; language disorder; autism; fetal alcohol syndrome; traumatic brain injury; and hearing impairment. Qualitative information can also be quantified, and compared with the standardisation sample. In sum, for the purposes of this study, the CORE battery was administered to provide a comprehensive overview of neuropsychological function: time constraints meant that expanded tests were not administered.

Full details on materials and scoring procedures, are available in the manual. Briefly however, test materials are packaged in a holdall, and include a manual, stimulus booklet and other stimulus equipment, and record form booklets. In terms of scoring, raw scores are converted into scaled scores in a similar way to the Wechsler intelligence tests, so that the mean is 100, with a standard deviation of 15. A summary of descriptions of the subtests, and test domains is also provided in Table 1.

Table 1: Description of the NEPSY Subtests, adapted from Korkman, et al (1998).

Domain and Subtest	**Description**
Attention/ Executive Function	
Tower	This assesses the executive functions of planning, monitoring, self-regulation, and problem solving. The child moves three coloured balls to target positions on three pegs in a prescribed number of moves. There are also rules to which the child must adhere on this timed task.
Auditory Attention and Response Set	This continuous performance tests assesses ability to be vigilant and to maintain selective auditory attention, as well as ability to shift set, to maintain a complex mental set, and to regulate responses to contrasting and matching stimuli. Having learned to respond to *red* in Part A, the child is then asked to shift set and respond to contrasting stimuli in Part B (**When you hear *red*, put a yellow square in the box**).
Visual Attention	This assesses speed and accuracy with which a child can scan an array and locate a target. The child scans the array of pictures and marks the target as quickly and as accurately as possible. Older children (aged 5 and above) get a random array and a complex array).
Language	
Phonological Processing	The first task in this subtest assesses the capacity to identify words from segments and to form an auditory gestalt. The child identifies a picture from an orally presented word segment. The second task assesses phonological segmentation at the level of letter sounds and word segments. The child creates a new word by omitting a word segment (syllable) or letter sound (phoneme) or by substituting one phoneme for another. (e.g. bike – bake).
Speeded Naming	This assesses the ability to access and produce familiar words rapidly. The child names items by size, colour and shape.
Comprehension of Instructions	This is designed to assess the ability to process and respond to verbal instructions of increasing syntactic complexity. This involves pointing to target shapes by colour position and relationship to other figures in response to verbal instruction.
Sensorimotor Functions	
Fingertip Tapping	This assesses finger dexterity. The child taps the index finger against the thumb 32 times as quickly as possible (simple movement). The child also taps the fingers sequentially against the thumb from index to little finger (complex movement) as quickly as possible.

Table 2: Continued Over

Table 2 continued: Description of the NEPSY Subtests, adapted from Korkman, et al (1998).	
Imitating Hand Positions	This assesses the ability to imitate a hand position from a model. The examiner models a hand position, and the child attempts to reproduce it.
Visuomotor Precision	This assesses fine motor skills and hand-eye coordination. The child draws a line inside a track as quickly as possible. There are two levels of complexity.
Visuospatial Processing	
Design Copying	This assesses visuomotor integration. The child copies two-dimensional geometric shapes of increasing complexity, using pencil and paper.
Arrows	This assesses the child's ability to judge line orientation. The child looks at an array of arrows around a target and indicates the two arrows that point to the center of the target.
Memory and Learning	
Memory for Faces	The child identifies the gender of a series of faces shown from the Stimulus Booklet as an attention focussing device. The child then selects the faces from three face arrays. After a 30 minutes delay, the child is asked to select the same faces from new three face arrays.
Memory for Names	The child learns the names of each of eight children depicted in line drawings over three trials. After a 30 minute delay, the child is asked to name the eight children.
Narrative Memory	This is assessed under free recall and cued recall conditions. The child listens to a story and then recalls it. In the cued recall condition, the child is asked questions to elicit details that were not reported in the Free recall section.

Psychometric Properties

Full details on the psychometric properties are available in the appropriate manual (Korkman, et al, 1998), and some relevant details of the psychometric properties are summarised in Appendix 2.

The NEPSY seems to show adequate sensitivity, reliability and validity (Korkman, 1998). It also has particular strengths in its construction. For instance, children with a wide range of cognitive problems were tested in establishing the psychometric properties, giving the test particularly useful clinical utility. The age range of three to twelve years also meant that the test would be able to cover a wide range of developmental abilities. In addition, the tests were also specifically designed for children, and were particularly novel interesting and engaging (Kaplan, 1998). The fact that they were contained in one battery was also convenient. However there were two factors that required consideration in using the test with a learning disabled population.

Firstly, children with IQs below 80 had not been included in the standardisation procedures. Nevertheless, the test had been standardised using children with autism and specific learning difficulties, and had a wide age range. It was therefore felt that the NEPSY would have sufficient sensitivity with low test floors, to gain meaningful information regarding test performance, from learning disabled children for the current study. Moreover, as far as it is known, there are no neuropsychological tests that have been specifically designed for learning

disabled people. Instead, it has been recognised that many of the standard neuropsychological tests have to be adapted (Sabbadini, et al, 2001), until more research is done in this area.

Secondly, some of the children in the current study were older than the age range designed for the NEPSY. However, childrens neuropsychological tests have been adapted before for use with adults with learning disability, (Wilson, 1995; Hon, Huppert, Holland and Watson, 1998) and have provided sensitive measures of performance where adult versions of the test may prove too difficult. Given that only five participants were above the age range of thirteen (13 years 0 months; 13 years 3 months; 13 years 7 months; 13 years 9 months; and 14 years 10 months), it was felt that this would be an acceptable adaptation to make. In sum, there were many strengths to the NEPSY battery, and it was felt to provide an appropriate way of comprehensively assessing neuropsychological function.

Use of Scaled and Raw Scores

Both the WISC-III-UK, and NEPSY battery are standardised in such a way, that scaled scores can be calculated to be compared with a normative value of 100, with standard deviation of 15. Thus, scaled score information enabled the performance for a given individual to be compared with the appropriate normative sample. This gave an impression of how far an individual participants performance differed from people of a similar age, without learning disability, and therefore provided important information about relative developmental level. However, as previously mentioned, the WISC-III-UK loses sensitivity to individual performance,

when a person's ability approaches floor level of the tests in the battery. Thus, scores for people in the lower range of IQ may be unreliable because it may not accurately assess their performance. A similar problem may also apply to the NEPSY because it has not been standardised on a learning disabled population either. For this reason, raw score data was also analysed in the current study. This data may provide a more sensitive measure of performance for each individual because scores do not need to be collapsed into discrete scaled composites. This effectively extends floor level, but information on a person's age related performance is lost. On an individual basis then, raw scores potentially provide more accurate information of a person's ability, irrespective of age. Conversely, scaled scores provide age related information, but are potentially not as sensitive to lower ranges of performance.

Emotional and Behavioural Assessment

Test Description

The Developmental Behaviour Checklist (Einfeld, et al., 1992) was used to measure emotional and behavioural difficulties. (A copy is included in Appendix 2). It is designed to assess a broad range of behavioural and emotional disturbances in children and adolescents with learning disability, and there are two versions of the test, a Primary carer version and a Teacher version. The Teacher version was used in the current study for practical reasons. Asking the primary care givers to complete the form would have incurred additional practical requirements such as ethical consideration and administration time, which were already considerable.

However, given that teachers would spend a considerable amount of time with the participants, it was felt that they could provide adequate information (Einfeld et al., 1992). Whilst the school setting was different from home, there were likely to be influences such as complex social demands, and other expectations of behaviour such as ability to work, that could also provide a useful context to behaviour problems.

The Checklist consists of 94 questions. Each item is given a rating of '0', '1', or '2', depending on the teacher's perception of the degree that a particular behaviour is present in a child, during the past two months. '0' represents "not true as far as you know", '1' represents "somewhat or sometimes true," and '2' represents " very true or often true." If a question is not applicable to a relevant child, then it would be scored '0'. There is also an opportunity to provide additional information about the teacher's perception of the level of disability, physical handicaps, and impact that the relevant participant's behaviour problems has on teaching and learning.

Two levels of interpretation of scores were used in the current study. There was a Total Behaviour Problem Score (TBPS), which was the sum of all scores, and represented an overall measure of behavioural / emotional disturbance. There were then six subscale scores, giving dimensions of disruptive, self-absorbed, communication disturbance, anxiety, social relating, and antisocial behaviour. Scores could also be converted to percentile ranks, to obtain score profiles, if required.

Psychometric Properties

Full details of these are available in the appropriate manual (Einfeld, et al., 1992), and relevant information is also summarised in Appendix 2.

On the whole, the psychometric properties of the DBC seemed fair to adequate. Some of the studies used to establish psychometric properties, used small subject samples, and age ranges were also not reported in detail. In addition, some of the correlations in reliability studies were also only moderate. However, the main advantage of using the DBC was that it was specifically designed for a learning disabled population, who often have complex emotional and behavioural difficulties, that are often hard to distinguish (Embregts, 2000).

Procedure

Planning the Study

The experimenter had several meetings with the school head teacher, to discuss the general aims of the project, and any practical considerations involved in testing the children in the school. It was felt that basing the study at school would minimise the amount of administration required, as it would be easier to access the children there, rather than test them at the local Child and Family Mental Health Department. This was especially important given that the children would be tested over several sessions.

Ethical Procedures

Extensive ethical procedures were required, as the study involved children with learning disability. Appropriate documents are enclosed Appendix 1. Ethical approval was gained from the Psychiatry/ Clinical Psychology Research Ethics Sub-committee, and Paediatric and Reproductive Medicine Research Ethics Sub-committee of the Lothian Research Ethics Committee. Written permission was also required from the appropriate director of education, and relevant Consultant Community Paediatricians.

Case Notes

The community child health records for the participants were reviewed for information on available aetiology, medication regime at the time of testing, and previous clinical intervention.

Testing the Participants

Administration of the WISC-III-UK and NEPSY was counterbalanced, so that effects of boredom or non-adherence could be controlled. This was achieved by randomising the order that the children would be tested. The order of presentation was then alternated with each pupil, so that the first pupil started with the NEPSY, the next pupil to be tested started with the WISC-III-UK, and so on. Twelve children were administered the NEPSY first, followed by the WISC-III-UK, and eleven children were administered the WISC-III-UK first, followed by the NEPSY. Testing took place over a period of four months. Each child was tested in several sessions, the minimum being two sessions, and the maximum being five. These sessions were usually done within four

weeks of each other with one exception, where one child had a space of three months between the first and last testing sessions due to organisational difficulties. Individual testing sessions lasted from 15 to 45 minutes, and depended on the experimenter's perception of how well a child was participating. For instance, sessions would be stopped, if a child appeared to be losing concentration. Total testing time for each child ranged from 90 minutes to four hours.

The experimenter supplied all relevant teachers with written information regarding the purpose of the study, and a timetable for the testing sessions. The experimenter then came to the child's classroom at the appropriate time to collect the child (and escorted the child back to the classroom at the end of each session). The experimenter introduced themselves to the child, and at the beginning of the first session, briefly explained the procedure to the child, saying that they would like them to help them with some work, and that they would be doing some writing, drawing and puzzles. It was also explained that they would work for 20 minutes, and then be given a toy sticker, as a reward for helping. The child was asked if they wanted to help, as it was felt necessary to make some effort to gain consent to the procedure, even though the participants may not have been able to give full informed consent. At the end of every first session, each child was asked if they wanted to come back on another day, and all children agreed. Only one child asked for the session to be stopped, on two separate occasions. This may have been because this participant had co-morbid ADHD, and had particular difficulty concentrating for extended time. One other session was stopped for another child when the experimenter found out from them that

they had missed a favourite lesson. All other children appeared to enjoy participating, and again this was taken as implicit consent.

The majority of testing took place in the 'Doctors room' or the 'Occupational Therapists' room of the medical block, within the school. These were very quiet rooms, away from the main part of the school. On the few occasions when these rooms were occupied, the 'resource room' of the school was used which was nearer to the main thoroughfare of the school, but still had satisfactory requirements.

The standardised procedures, as specified in the manuals for the WISC-III-UK and NEPSY battery were followed as far as possible. Full details of the procedures are found in the appropriate manuals. On completion of data collection, one participant's scores on the 'design copy' subtest of the NEPSY was missing. In addition, the participant who had had the session stopped early because of missing a favourite lesson was not tested on the 'object assembly' subtest of the WISC-III-UK. Scores for these missing subtest were therefore extrapolated, according to the guidelines given in the WISC-III-UK, and NEPSY.

Every effort was made to establish a rapport with the children, and to maintain motivation to participate, to ensure that assessment reflected best performance. However, there were several children with attentional problems, who required frequent refocusing on tasks, and sessions were therefore kept short. One child with autistic features also required frequent

refocusing. Nevertheless, many of the children were able to attend to the tasks appropriately, and the experimenter was satisfied that testing was done under optimal conditions, as specified by Lezak (1995).

Developmental Behaviour Checklist (Teacher's version)

The written information given to the teachers specified that they would be asked to complete a questionnaire, and written instructions on completing the questionnaire were also supplied. Teachers were also asked individually by the experimenter to complete the DBC. In accordance with the head teacher's wishes, the questionnaires were not given out until the last three weeks before the end of school term, so that they did not clash with other work commitments. All teachers had worked with the relevant child, for at least ten months.

Analysis

A within subjects design was used. Descriptive information was analysed using Microsoft EXCEL 97. All inferential statistics were analysed using SPSS for Windows (Statistical Package for Social Sciences), version 10.0.

RESULTS

Twenty-three participants, with age range 7 years 6 months to 14 years 10 months, and mean age of 11 years 11 months, were assessed using the WISC-III-UK (Wechsler, 1992); the NEPSY neuropsychological battery (Korkman, et al., 1998); and the Developmental Behaviour Checklist (Einfeld, et al., 1992).

HYPOTHESIS ONE

Global or Specific Deficit?

Summary of hypotheses

It was argued that a brain and behaviour framework would provide a better account of learning disability because it enables the identification of a wide range of cognitive strengths and weaknesses. This assumption was based on the argument that learning disability is characterised by specific cognitive impairments, as opposed to a global developmental delay. Thus, hypothesis 1a) stated that there will be no significant correlation between IQ and attention and executive function; hypothesis 1b) stated that there will be no significant correlation between IQ and sensorimotor function; hypothesis 1c) stated that there will be no significant correlation between IQ and visuospatial function; and hypothesis 1d) stated that there will be no significant correlation

between IQ and memory. In contrast, hypothesis 1e) stated that there will be a significant positive correlation between IQ and language

Summary of Descriptive Statistics

Descriptive data for individual subscale performances for the WISC-III-UK and NEPSY neuropsychological battery is included in Appendix 3.

Scaled Scores

Table 1 demonstrates the range, mean and standard deviations for Full Scale IQ scores and scaled NEPSY domain scores. Median and quartile ranges were also included as it was expected that this sample would show a relatively skewed range of function with particularly low scores, given that they were learning disabled.

	WISC-III-UK	NEPSY Domain Score				
	FSIQ	**Attention/ Executive Function**	**Sensorimotor Function**	**Visuospatial Function**	**Memory and Learning**	**Language Function**
Range	40-63	50-56	50-73	50-92	50-76	50-69
Mean	47.48	50.91	54.39	55.04	58.26	55.74
SDev	6.69	1.7	6.18	11.39	9.27	6.33
Median	46	50	50	50	54	53
Interquartile Range	6.3	1	7.5	1	15	11

Table 1: Summary of Descriptive Statistics for IQ and NEPSY Domain Scores (n=23).

It can be seen that mean and median scores across all conditions, were relatively similar, ranging from 47.48 to 58.26 for mean performance, and 46 to 54 for median performance. This indicated that most participants were performing to a similar level across all cognitive domains, and to a similar level indicated by Full Scale IQ. This suggested a pattern of global impairment, rather than specific skill deficit.

However, there was some indication of skewed performance. For instance, the range of scores, and mean and median for attention and executive function suggested a restricted distribution. For the remaining functions, distribution was more varied and uneven, where the mean scores tended to be higher than the median, suggesting that high outlying scores were inappropriately influencing the measure of central tendency. This was also indicated by the high upper range of scores, compared with low measures of central tendency. This variance in performance therefore seemed to indicate a range of ability profiles, in line with the general hypothesis.

Raw Scores

Table 2 shows the range, mean, standard deviation, median and quartile ranges for raw scores on the WISC-III-UK and NEPSY domains. With raw score data it was not possible to directly compare mean and median data across the separate domains, and so it was not possible to ascertain whether participants were performing better or worse in some domains compared to others, or in comparison to raw WISC-III-UK scores.

	WISC-III-UK	NEPSY Domain Score				
	Raw IQ	**Attention/ Executive Function**	**Sensorimotor Function**	**Visuospatial Function**	**Memory and Learning**	**Language Function**
Range	0-167	1-21	91-315	2-78	0-58	8-62
Mean	76.11	11.43	194.04	35.22	33.7	37.78
SDev	43.46	14.3	97.1	19.22	16.86	14.72
Median	77	8	135	33	32	34
Interquartile Range	47	8	198	22	25	26

Table 2: Summary of Descriptive Statistics for Raw IQ and Raw NEPSY Domain Scores (n=23).

However, the large standard deviations and interquartile ranges again suggested some evidence of variability of performance, in line with the hypothesis that participants would show different abilities for neuropsychological domains in comparison with IQ.

An important additional point to make however, concerned the sample of participants tested for the study. As indicted in Figure 1, the sample showed a skewed distribution of scaled IQ scores (below 51), with only four participants showing FSIQ between 56 and 63. This suggested that the participants did not reflect a representative sample of all ranges of learning disability, because the majority fell within the severe learning disability range of FSIQ < 55 (BPS, 2001), which contradicts normal prevalence (Plomin, 1999; Clements, 1992).

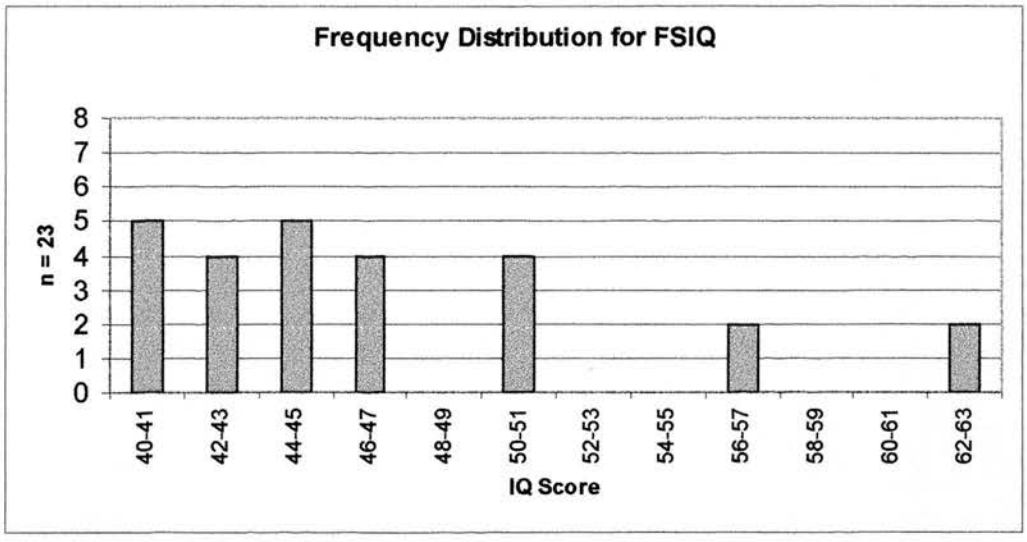

Figure 1: Distribution of scores for Full Scale IQ (n=23).

This negative skew was also shown in the frequency distribution for raw IQ scores, but to a lesser extent, demonstrated in Figure 2. Nevertheless, this thesis is investigating the applicability of a brain and behaviour framework to all people with learning disability, irrespective of ability level.

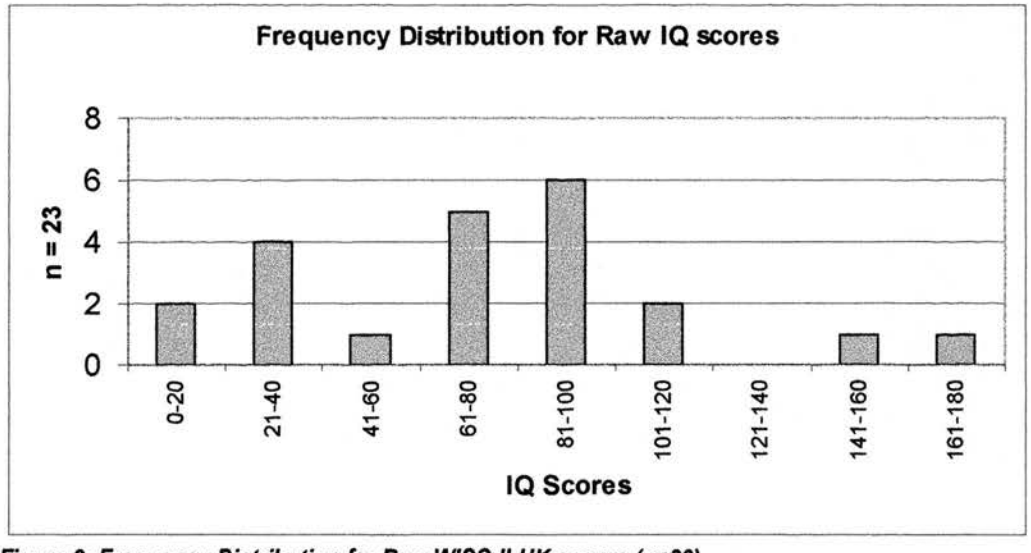

Figure 2: Frequency Distribution for Raw WISC-II-UK scores (n=23).

Further Analysis

Correlational analysis was used to further investigate the specific relationships between IQ and neuropsychological function. Non-parametric analysis was felt appropriate, given that both raw and scaled data showed uneven and skewed distribution, as well as the relatively small number of participants tested. Spearman Rank Correlation was used, with two tailed levels of significance throughout. As the number of correlations to be performed was relatively high, it was felt that setting a more conservative level of significance of $p < 0.01$ was merited. A priori power analysis was used to determine the number of participants required for the current study. Detterman et al (1992) achieved an effect size of 0.72, when they correlated IQ with other cognitive abilities such as memory, suggesting that all basic cognitive abilities relate to IQ. They also stated that most intellectual tests correlate with each other in the range of 0.7 and 0.8 (Detterman, et al, 1992). Thus, for an effect size of 0.8, using a two tailed probability, with alpha level of 0.01 and power of 0.8, it was estimated that fourteen subjects would be required in the current study (Machin and Campbell, 1987).

Hypothesis 1a)

When IQ was correlated with attention and executive function, there was no significant correlation between Full scale IQ and scaled attention and executive function ($r_s = 0.31$, $df = 21$, $p = 0.15$, n.s.) which supported hypothesis 1a). However, there was a significant positive correlation between raw score IQ and raw score attention and executive Function ($r_s = 0.66$, df =

21, p = 0.001), which does not support the hypothesis that IQ and attention and executive function are unrelated.

Figure 3, shows the relationship between raw IQ scores and raw scores for attention and executive function. It can be seen that one participant showed a better performance relative to the rest of the group, (although this performance was still poor, relative to people of similar age without learning disability).

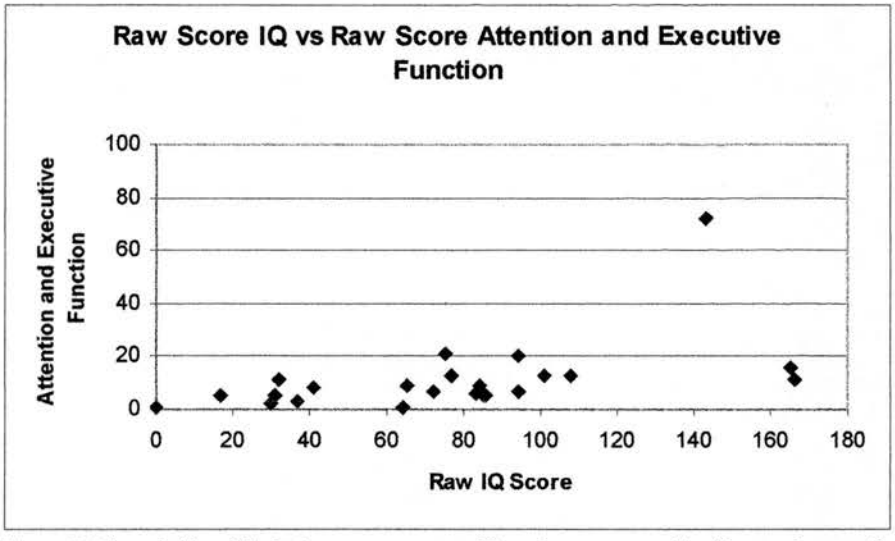

Figure 3: The relationship between raw score IQ and raw score attention and executive function, (n = 23).

However, this outlying score may have distorted the data, so that there appeared to be a false association between raw score IQ and raw attention and executive function. This was the oldest participant, aged 14 years and 10 months, and he was the only participant who was able to complete the Auditory Attention and Response Set task of the NEPSY. As a precaution, he was excluded from a further analysis, in order to see whether this would affect the findings.

Nevertheless, this had little affect on the correlation between Full scale IQ and scaled attention and executive function, (r_s = 0.24, df = 21, p = 0.29, n.s.). Nor did it have much affect on the correlation between raw IQ score and raw scores on attention and executive function, (r_s = 0.62, df = 21, p = 0.002). In sum, there was contradictory evidence for the support of hypothesis 1a).

Hypothesis 1b)

Analysis revealed a significant positive correlation between scaled IQ and scaled sensorimotor scores, (r_s = 0.62, df = 21, p = 0.002), and a significant negative correlation with raw score data (r_s = -0.57, df = 21, p = 0.004). These findings did not support the hypothesis, and suggested that there was a correlation between IQ and sensorimotor function.

Hypothesis 1c)

There was a significant positive correlation between Full scale IQ and scaled visuomotor scores (r_s = 0.66, df = 21, p = 0.001) and a significant positive correlation between raw IQ and visuomotor scores (r_s = 0.86, df = 21, p = 0.001). This did not support the hypothesis and suggested that IQ and visuomotor function were related.

Hypothesis 1d)

Further analysis showed a positive correlation between Full scale IQ and scaled memory and learning, (r_s = 0.51, df = 21, p = 0.013) that approached significance using the conservative estimate; and a significant positive correlation with raw IQ and memory and learning scores, (r_s =

0.73, p = 0.001). Thus, there seems to be mixed support for a significant association between these two variables, contrary to the hypothesis.

Hypothesis 1e)

Correlational analysis revealed a positive correlation between scaled IQ and scaled language function, (r_s = 0.5, df =21, p = 0.016) that approached significance using the conservative estimate, and a significant positive correlation between raw IQ scores and raw scores for language function, (r_s = 0.72, df = 21, p = 0.001).

To summarise, there was a significant correlation between IQ and sensorimotor function, visuospatial function, memory and learning, and language function for both scaled and raw scores. However, when using a more conservative level of significance, the correlations between Full scale IQ and memory and learning, and Full Scale IQ and language function, just failed to reach significance. Nevertheless, when a post hoc power analysis was performed, it seemed that most of these relationships achieved a moderate to high degree of power, even with the relatively small sample of participants. Given that a priori power analysis indicated that only 14 participants may have been sufficient to achieve satisfactory power for the relationship between full scale IQ and memory and language and full scale IQ and language function, it seemed that irrespective of developmental level, neuropsychological function may have been related to IQ, and this contradicts the first hypothesis. Furthermore, with the exception of sensorimotor function, raw score data analysis showed that when developmental age was excluded, the degree of correlation seemed even stronger. These findings are summarised in Table 3.

	IQ vs Attention and Executive Function	IQ vs Sensorimotor Function	IQ vs Visuospatial Function	IQ vs Memory and Learning	IQ vs Language Function
Scaled Scores					
r_s	0.31	0.62**	0.66**	0.51*	0.5*
Variance	9.6%	38.4%	43.6%	26%	25%
Effect Size	Medium	Large	Large	Large	Large
Statistical Power	0.09	0.72-0.86	0.86-0.94	0.43-0.57	0.43
Raw Scores					
r_s	0.66**	-0.57**	0.89**	0.73**	0.72**
Variance	43.6%	32.5%	79.2%	53.3%	51.8%
Effect Size	Large	Large	Large	Large	Large
Statistical Power	0.86-0.94	0.57-0.72	0.99	0.94	0.9-0.95

Table 3: Comparison of Correlation Coefficients for Scaled and Raw Score Data, Effect Size and Statistical Power (n = 23, df =21)
** $p < 0.05$ (2 - tailed)*
*** $p < 0.01$ (2 – tailed)*

However, the relationship between IQ and attention and executive function is less clear, and there was contradictory evidence for the finding that IQ and attention and executive function were dissociable. On closer inspection of performance for this domain, all subjects seemed to perform particularly poorly, relative to standardised normative values. This indicated that they may have been particularly impaired in this domain, relative to others, and five times as many subjects (120) would have been required to achieve satisfactory power of 0.8 (Bissonnette 2000), when correlating *scaled* IQ and attention and executive function.

Further Investigation into Attention and Executive Function and IQ

A correlation was therefore performed between the scaled attention and executive domain from the NEPSY, and the freedom from distractibility index from the WISC-III-UK. These measures of performance are normally thought to assess a similar cognitive construct, and should be expected to correlate highly (Korkman, et al., 1998). However, correlation between attention and executive function and freedom from distractibility was not significant ($r_s = 0.3$, $df = 21$, $p < 0.16$, n.s.), and similarly, post hoc power analysis indicated that a minimum of 120 participants would have been required to obtain a significant finding. This finding from the current study was compared with the findings of the special group validation studies from the development of the NEPSY Battery (Korkman, et al, 1998), in Table 4.

	NEPSY Attention and Executive Domain vs Freedom from Distractibility Index (WISC-III-UK)
Current Study (n = 23)	0.30
NEPSY Studies (Korkman, et al., 1998)	
Non-clinical Sample (n = 127)	0.35
ADHD Sample (n = 42)	0.19
Specific Learning Difficulties Sample (n = 41)	0.22

Table 4: Comparison of the Correlation between Attention and Executive Function, and Freedom from Distractibility Index, from the Current Study and NEPSY Studies

This lack of significance and low power, may therefore mean that the relationship between attention and freedom from distractibility for the current sample was attenuated, as with the non - learning disabled sample with ADHD, and non-learning disabled sample with specific

learning difficulties. Thus, performance patterns for children with learning disability may still indicate a specific attentional and executive deficit, in line with the first hypothesis.

Differences between domain scores

In contrast, another indication of global impairment is the degree of overlap in the amount of variance attributable to neuropsychological function and IQ. Nevertheless, Table 1 shows that scaled scores for attention and executive function seem particularly low compared to scaled scores for the other NEPSY domains. This again suggests that these participants may have had a specific neuropsychological deficit. Thus, an alternative method of investigating this would be to see if these differences were significant, and because these scores were scaled, it was possible to treat them as equivalent levels of the same dependent variable. Friedman ANOVA tests were therefore performed. Apriori post hoc analysis was conducted using the z-value of the Wilcoxon signed ranks test, which corrects for tied scores (Clark-Carter, 1997). A one tailed, Bonferroni corrected level of significance of 0.01, was also used, as suggested by Clark-Carter (1997). Thus, it was anticipated that performance on attention and executive function would be significantly impaired, in comparison to other neuropsychological domain scores of sensory motor function, visuomotor function, memory and learning, and language. A priori power analysis was used to determine the number of participants required in the current study. As the NEPSY is a relatively new psychological battery, no information was available from previous literature to indicate a suitable effect size. Therefore, a large effect size of 0.8 was used to determine the number of subjects required, as recommended by Clark-Carter (1997). Thus, for a large effect

size of 0.8, using and one tailed probability, with alpha level of 0.01 and power of 0.8, 20 participants would be required (Machin, and Campbell, 1987).

As expected, there was a significant difference between NEPSY domain scores, where $\chi^2_F = 24.09$, df = 4, p = 0.001. Furthermore, a priori analysis showed that attention and executive function was significantly worse than memory and learning (Z = -3.44, p = 0.001, n = 22) and language function (Z = -3.3, p = 0.001, n = 18). However, the difference between attention and executive function and sensorimotor function just failed to reach significance (Z = -2.52, p = 0.012, n = 18), and the difference between attention and executive function and visuospatial function was not significant (Z = -1.52, p = 0.13, n = 23).

Post hoc power analysis was conducted to investigate these findings further. Clark-Carter's recommendation was used, where each Z score is divided by the square root of the total number of participants, to obtain the relevant effect sizes (Clark-Carter, 1997). This indicated that effect sizes of 0.7 (n=22), 0.7 (n=18), 0.5 (n=18) and 0.3 (n=23) were obtained for the comparisons between attention and executive function and memory and learning; language; sensory motor function and visuo-spatial function, respectively. Thus, the difference between attention and executive function and memory and learning, and attention and executive function and language, achieved moderate to high degree of power with the given numbers of particpants, (0.77 and 0.65 respectively). This seemed to provide some additional support that performance on attention and executive function was significantly worse than language and memory and learning, in these participants, when developmental level was taken in to consideration.

The difference between attention and executive function and sensory motor function achieved a lower power of 0.33, and the difference between attention and executive function and visuospatial functioning achieved a much lower power, of 0.15. This meant that over 100 participants would have been required to achieve sufficient power, so that it was less likely that attention and executive function was dissociable from visuospatial function.

To summarise the findings of the first hypothesis, it was anticipated that IQ and NEPSY Domain scores would not correlate, with the exception of IQ and Language Function. This would support the argument that learning disability was characterised by specific neuropsychological impairment rather than global developmental delay. Both scaled and raw scores were used in the analysis. For raw score information, all of the NEPSY Domain scores correlated with IQ, indicating that neuropsychological function was related to intelligence in children with learning disability. Participants therefore seemed to show global impairment, irrespective of specific developmental level. However, when scores were scaled, which effectively stratified each child according to their developmental level, the relationship between attention and executive function, and IQ seemed to be attenuated.

Thus, when *differences* between scores for neuropsychological domain function were analysed using ANOVA, the finding that participants were particularly impaired in attention and executive function, relative to memory and learning, and language function seemed to hold true. Hence, there was conflicting support for both global and specific deficit hypotheses of learning disability.

HYPOTHESIS TWO

Are Behaviour Problems and Executive Function Related?

The second hypothesis predicted that executive dysfunction might lead to the types of behaviour problems experienced by people with learning disability, because they are directly related cognitive constructs. Thus, hypothesis 2a) stated that there would be a significant negative correlation between scores for attention and executive function and total behaviour problem scores; hypothesis 2b) stated more specifically that there would be a significant negative correlation between attention and executive function and disruptive behaviour scores; hypothesis 2c) stated that there would be a significant negative correlation between attention and executive function and self-absorbed behaviour; and hypothesis 2d) stated that there would be no significant correlation between the other neuropsychological domains of sensorimotor function; visuospatial function; memory and learning; and language function, with behaviour difficulties because these functions are not directly related with one another.

Summary of Descriptive Statistics

Descriptive data for individual subscale performance for the Developmental Behaviour Checklist is included in Appendix 3. Table 5 shows descriptive information for total behaviour problem scores, disruptive behaviour scores and self-absorbed behaviour scores from the

Developmental Behaviour Checklist. It can be seen from the low median values, and large ranges, that scores for the behaviour scale are skewed towards the lower range.

In the validation sample for the Developmental Behaviour Checklist (Einfeld, et al., 1992), average scores, at the 50th percentile, lie between 23 and 27 for people with moderate learning disability.

	Total Behaviour Problem Score	Disruptive Domain	Self Absorbed Domain
Range	0-119	0-34	0-27
Mean Scores	27.35	7.91	4.43
Standard Deviation	29.05	8.68	6.56
Median Scores	22	5	3
Interquartile Range	33	14	5

Table 5: Descriptive Statistics for Total Behaviour Score, Disruptive and Self absorbed behaviour subscales from the Developmental Behaviour Checklist (n=23)

Similarly, the average score for Disruptive Behaviour is 6, and the average score for self-absorbed behaviour is between 1 and 3. Thus, in the current sample, almost half of the children showed above average behaviour problems compared to the standardisation sample of the DBC (Einfeld, et al., 1992).

For further investigation of the relationship between neuropsychological function and behaviour problems, non-parametric analysis using Spearman's Correlation Coefficient was felt to be appropriate, given the skewed behavioural scores, and small subject numbers. Two-tailed

level of significance was used throughout, and the same conservative level of significance of $p < 0.01$ adopted for hypotheses 1a) – 1e) was also used here. As before, a priori power analysis indicated that fourteen participants would be required for the current study, based on a large effect size of $r = 0.8$, (Detterman et al, 1992), with a two tailed probability, alpha level of 0.01, and power of 0.8.

Hypothesis 2a)

For scaled scores, correlation between attention and executive function and total behaviour scores was not significant ($r_s = -0.05$, df 21, $p = 0.827$, n.s.). For raw scores, analysis showed a negative correlation ($r_s = -0.44$, df 21, $p = 0.04$, n.s.), which failed to reach the conservative level of significance. Post hoc power analysis revealed that a medium to large effect size was achieved (Clark-Carter, 1997), with a moderate power of between 0.21 and 0.3. This indicated that between 60 and 70 participants would have been required to achieve sufficient power, and an acceptable significant finding.

Hypothesis 2b)

The types of behaviour most likely to be associated with attention and executive problems were thought to be disruptive and self-absorbed behaviour. Further analysis between scaled score attention and executive function, and disruptive behaviour, revealed no significant

correlation (r_s = 0.13, df = 21, p = 0.54, n.s.); neither was there a significant correlation with raw score attention and executive function, and disruptive behaviour (r_s = -0.3, df = 21, p = 0.18, n.s.).

Hypothesis 2c)

There was no significant correlation between scaled score attention and executive function and self-absorbed behaviour (r_s = -0.19, df = 21, p = 0.39, n.s.). However, with raw score attention and executive function, and self absorbed behaviour, negative correlation failed to reach significance using the conservative estimate (r_s = -0.42, df = 21, p = 0.046). Post hoc power analysis again revealed that between 60 and 70 participants would have been required to achieve a meaningful significant finding.

Hypothesis 2d)

For scaled scores, analysis revealed there was no significant correlation between sensorimotor function and total behaviour problem score (r_s = -0.18, df = 21, p = 0.42, n.s.); nor was there a significant correlation between visuospatial function and total behaviour problem score (r_s = 0.05, df = 21, p = 0.83, n.s.); nor between memory and learning, and total behaviour problem scores (r_s = -0.24, df = 21, p = 0.27, n.s.), nor between language function and total behaviour score (r_s = 0.09, df = 21, p = 0.68, n.s.).

For raw scores, analysis revealed there was no significant correlation between sensorimotor function and total behaviour problem score (r_s = 0.09, df = 21, p = 0.67, n.s.); nor was there a significant correlation between visuospatial function and total behaviour problem score (r_s = -0.29, df = 21, p = 0.18, n.s.); nor between memory and learning, and total behaviour problem scores (r_s = -0.28, df = 21, p = 0.19, n.s.). Finally, there was no significant correlation between language function and total behaviour score (r_s = -0.28, df = 21, p = 0.19, n.s.).

Summary of Findings for Hypothesis Two

As the correlation between raw score attention and executive function and total behaviour problems just failed to reach the conservative level of significance, as did the correlation between raw score attention and executive function and self-absorbed behaviour, hypotheses 2a), and 2c) had to be rejected. Thus, at best, only a tenuous trend for a relationship between behaviour difficulties and attention and executive deficits may have been demonstrated. However, this requires further investigation. In contrast, in terms of scaled scores, which take account of developmental stage, there seemed to be no relationship between behaviour difficulties and attention and executive function. In addition, hypothesis 2b) was rejected, for both scaled and raw score data, where there was no correlation between attention and executive function, and disruptive behaviour. As expected, there were no significant correlations between total behaviour problems and other neuropsychological domains for either scaled score data or raw score data.

DISCUSSION

Global or Specific Deficit?

In order to investigate whether a brain and behaviour framework was applicable to learning disability, the first hypothesis argued that neuropsychological function would be dissociable from IQ. This would mean that learning disability would be better characterised by the specific cognitive deficit hypothesis (Ellis, 1963), as opposed to global developmental delay (Detterman, 1987). In the current study however, there was conflicting evidence for both the global and specific deficit account of learning disability.

For instance there was clear correlations between sensorimotor function and IQ. This was true, irrespective of measures that accounted for developmental age, or for those which disregarded this. Similarly, there was also a positive correlation between visuospatial function and IQ, irrespective of developmental age. Thus, some neuropsychological functions were strongly associated with general intellectual ability, suggesting that children with learning disability were globally impaired.

In terms of memory and learning, and language function, results were more mixed. Again, there were clear correlations between these neuropsychological functions and IQ, for scores that reflected performance irrespective of developmental age. Whilst the association

between language and IQ was expected, the association between memory and IQ was not. However, these associations just failed to reach significance, when scores were based on performances stratified for developmental age. Nevertheless, the level of significance was close to the conservative estimate, so that it may have been more appropriate to suggest that a Type II error had occurred, and that the null hypothesis was erroneously accepted. Indeed, post hoc power analysis revealed that power was relatively high, and only a relatively small increase in the number of participants, may have led to a significant finding. This would then have lent further support to the global developmental hypothesis.

Thus it seemed that Detterman, et al (1992) may have been correct in their assumption that all basic cognitive abilities are inter related. In addition, the strong effect sizes obtained in the current study also suggested that these associations were particularly strong, with lower IQ, given that the majority of participants had severe learning disability. This again highlights the argument that people with learning disability are globally impaired (Detterman, et al., 1992; Zigler, 1967). Furthermore, when performances were analysed using standardised scores stratified by age, because different neuropsychological domains were not consistently dissociable from IQ, it seemed appropriate to conclude that the current sample showed global developmental *delay*, relative to children without learning disability, as suggested by Groff and Linden (1982).

In contrast, although there was a clear correlation between attention and executive function, and IQ, when using performance irrespective of age, there was a clear lack of association when developmental age was considered. Thus, when transforming raw scores to the

chronological age most likely to be associated with it (Chapman and Hesketh, 2000), the association between IQ and attention and executive function was lost. Children with learning disability therefore seemed particularly impaired in attention and executive function, when compared to normative scores of non learning disabled peers, and this impairment also seemed independent of Full Scale IQ. In addition post hoc power analysis revealed that here, power was particularly low, compared to that obtained with associations between other neuropsychological domains and IQ, and that testing a minimum of 120 participants would have been required to show a significant association between attention and executive function, and IQ.

This dissociation was still apparent, when scaled attention and executive function was correlated with the freedom from distractibility index. This index, one of four identified from the WISC-III-UK, is assumed to underlie the attention and concentration aspects of intelligence (Wechsler, 1992). It therefore seemed highly likely that these two variables would correlate, if all cognitive functions measure 'g'. However, the consistent dissociation seemed to provide additional support that participants in the current study were particularly impaired in attention and executive function.

Furthermore, this finding compares well with the special group studies used when validating the NEPSY battery (Korkman, et al, 1998). Here, children with Attentional Deficit Hyperactivity Disorder showed a similar lack of correlation between attention and executive domain scores, and freedom from distractibility index scores, relative to other associations, measured using the WISC-III-UK (Wechsler, 1992). Similarly, children with specific learning

difficulties also showed this. Korkman et al (1998) therefore concluded that this was because of *specific* deficits in attention and executive function. Thus, as Ellis (1969) and Hooper, et al., (1993) suggest, learning disability may be characterised by specific cognitive deficits, supporting the specific deficit hypothesis.

In the current study, this interpretation is tenuous however, because a specific deficit in attention and executive function was only found when scaled scores, or scores that stratified performance by age level, were used. When raw scores were used, irrespective of age level, a strong positive correlation with IQ remained. In fact, other associations between IQ and NEPSY domains, were also particularly strong when using raw scores. It could therefore be argued that because floor level was effectively extended when using raw scores, this provided a more accurate and sensitive measure of performance, and so provided even stronger support for the global delay hypothesis.

Hence, a more restricted range of scores occurred with scaled scores, and this perhaps led again to a Type II error when correlating scaled attention and executive function with IQ, so that the null hypothesis was erroneously accepted. This seems particularly apparent when language function and IQ were considered. Here, a strong association was expected because of the role of language in mediating cognitive function (Lezak, 1995, Spreen and Strauss, 1998). However there was a more powerful relationship when using raw, as opposed to scaled scores. Nevertheless, it would be expected that if the measures were reliable, these associations would be of a similar magnitude. Thus, it seems that while there was strong support for the global delay

hypothesis in learning disability, this study had also shown that the use of scaled scores, standardised using non learning disabled people, has questionable reliability when applied to people with severe learning disability. Hence, as the British Psychological Society (2001) suggests, such tests cannot be carried out reliably for people with the lowest level of intellectual functioning, and this lack of reliability makes their use highly questionable.

In sum, using raw scores in the current study seemed to provide a more sensitive measure of performance, and subsequently provided further evidence for 'g', or the inter-correlation of all cognitive variables (Detterman, 1999). However, when individual performance was observed, it was still apparent that participants had *particular* difficulty with some of the neuropsychological tasks, relative to others.

For instance, all participants seemed particularly impaired on the tasks for the attention and executive domain. In fact, all participants except one were unable to do the 'auditory attention and response set' task (Korkman, et al, 1998). This task was a continuous performance task assessing ability to be vigilant, maintain selective auditory attention, as well as ability to shift set, maintain a complex set, and regulate responses – sometimes having to respond to matching stimuli, and sometimes having to respond to contrasting stimuli, (Korkman, et al, 1998). Participants had to listen to auditorily presented words, at a rate of one per second. In Part A of the test, they had to put small red squares into a box whenever they heard the word 'red', but were not to respond to any other word. The words for the teaching example were: 'now, peg, that, RED, there, yellow, blue, take, RED, thing, now,' so that some were innocuous non-colour words,

and some were colour words which participants would have to withhold a response (unless the word was red). For Part B, participants had to put a yellow square in the box when they heard the word red, a red square in the box when they heard the word yellow, and a blue square in the box when they heard the word blue. Here, the task was much more complex, requiring maintenance of a complex mental set, but also cognitive flexibility because of the simultaneous processing required to monitor ongoing performance.

Even though Part A of the task was considerably easier, participants still had great difficulty with this, and many were not even able to compete the teaching example. Whilst this was potentially due to the relatively complex instructions, the impression was that some understood that they had to put a red square in when they heard the word red, but could not bring about the response quickly enough. Others put squares in for every colour that they heard. Thus, perceptual and response speed, and ability to hold in mind all the instructions may also have had an important influence on task performance. Nevertheless, participants were significantly more impaired on this domain, relative to the other domains, which specifically assessed visuomotor speed and memory for instructions. In other words, it seems that participants were specifically impaired in attention and executive function.

Similarly, in the study by Detterman et al., (1992), the relationship between IQ and basic cognitive tasks was investigated in learning disabled and non learning disabled people. Whilst the authors argued that all basic cognitive tasks correlated with intelligence, the number of trials that learning disabled subjects took to complete the memory task seemed to indicate that they were

particularly impaired on this, relative to the control subjects. In addition, there seemed to be evidence that the task did not specifically delineate memory function, as it may have required a significant executive component.

In the current study then, when looking at significant differences in performance on neuropsychological domains, as opposed to correlations with IQ, children with learning disability seemed particularly impaired in attention and executive function, relative to memory and learning and language function. Thus, as Vicari et al., state "intellectual disability is not a uniform condition," rather "it is characterised by a deficit in a complex cognitive system, in which some cognitive disabilities can be disrupted more than others," (Vicari, et al, 1995, p536). In contrast, when correlational design had been used to investigate the relationship between neuropsychological function and IQ, there seemed to be a high degree of association. These conflicting findings may therefore indicate that learning disability is better characterised as *both* a global and specific cognitive impairment. As Hooper et al suggested, learning disability might be better conceptualised as "falling along a continuum of *impaired* neurological development." (Hooper, et al., 1993, p282)

This apparently conflicting finding suggests that the methodology used to investigate the relationship between IQ and neuropsychological function is extremely important. If a global measure, such as Full scale IQ is used to assess performance, then clearly, people with learning disability will appear to be globally delayed. As Chapman and Hesketh state "comparisons to chronologically age-matched children, of course, simply confirm delays in learning," (Chapman

and Hesketh, 2000, p85). Thus, using Full Scale IQ, effectively matches a child with learning disability, to a child without, and so a child with learning disability will show relative global impairment. It is therefore argued in this thesis, that the use of the IQ test has led to the circular argument that people with learning disability are globally impaired, and that global theorists have wrongly assumed that low IQ *causes* low ability.

Conversely, if a range of measures are used, pertaining to known neuropsychological functions such as attention and executive function, memory and learning, and so on, and the tasks that are used to gain those measures are all set at a consistent developmental level, then it may be that a range of cognitive strengths and weaknesses will be found, irrespective of level of intelligence. Thus, delineating a range of cognitive strengths and weaknesses, may provide a more valid account of learning disability, and may inform the debate regarding global versus specific cognitive deficit more appropriately. A better account of learning disability then, seems to be that specific underlying deficits may have a subsequent impact on global development. Investigating the developmental patterns in children with specific types of learning disability, using a brain and behaviour approach, would therefore be an interesting area for future research.

This use of dissociation is a well known concept in neuropsychology (Shallice, 1990), and can provide a more valid methodology, in investigating cognitive function. In fact, Wechsler states in the WISC-III-UK manual:

> "Although standard subtest scores and IQs are important pieces of information in neuro-psychological evaluations, performance on the Wechsler scales is considered primarily in combination with the patient's performance on other neuro-psychological tests administered as part of the neuro-psychological evaluation. Often in neuro-psychological evaluations, qualitative interpretation of test performance, analysis of errors and testing of the limits are viewed as important or more important than the scores themselves."
>
> (Wechsler, 1992, after Kaplan, 1988, p10).

Thus it is not the case that an IQ score per se is inappropriate, although deriving that IQ score must be made on the basis of reliable and valid testing. Rather, it is the use of Full Scale IQ as the only measure of overall cognitive function in people with learning disability that is questioned in this thesis. Even though a measure of adaptive behaviour is also recommended, as a way of increasing the validity and reliability of current diagnostic methods, classifying a person as learning disabled or not, usually comes down to their Full scale IQ score (Dodd and Webb, 1998; Evers and Hill, 1999). It is clear that this is not a sufficient measure of cognitive ability, and a change in diagnostic criteria therefore seems merited. A change in the types of assessments used for people with learning disability is also merited. This would require the development of reliable and valid tests, specifically designed for use with learning disabled people as well as professional confidence in their use. In addition, an understanding that classification of learning disability on the basis of IQ score does not equate with a reliable and valid diagnosis of the actual

phenomenology of learning disability, is required. Thus, clinical psychologists have a responsibility to acknowledge this need for development in their practice.

Indeed recommendations for improving assessment for people with Down syndrome and Dementia have been suggested for some time (Crayton and Oliver, 1993; Janicki, et al 1996; Aylward, et al 1997). However, despite similar recommendations for applying a brain and behaviour approach to all types of learning disability (e.g. Bregman and Hodapp, 1991; Scachter and Demerath, 1996; W.H.O. 1985) it is only very recently that this type of methodology is being applied. For instance, 'behaviour phenotyping,' is a method increasingly used to define those behaviours associated with a specific chromosomal or genetic syndrome, including cognitive processes and social interaction (Flint, 1996). Thus, detailed accounts of the behaviour phenotype associated with particular conditions such as Down syndrome, (Chapman and Hesketh, 2000), and Fragile X syndrome (Mazzocco, 2000) are emerging.

In addition, a brain and behaviour framework is also useful for providing clinical information for habilitative purposes. In the same way that neuropsychological assessment is applied to people with acquired brain injury (Lezak, 1995), with the use of qualitative information and error analysis, (Wechsler, 1992), comprehensive neuropsychological evaluation can also provide a useful assessment of cognitive functions in *individuals* with learning disability (Hooper, et al, 1993). This has particular implications for children, where it would seem important to identify all impediments to learning in individual children as early as possible, in order to maximise the effects of intervention (Stanley and Dolby, 1999; Wishart, 1996).

Neuropsychological methodology therefore tends to look at individual profiles of cognitive strengths and weaknesses, as well as acknowledging the importance of specific aetiology (Lezak, 1995). However, the current study assessed a group of children with mixed aetiology, and assessed group as opposed to individual performance. These factors could therefore be seen as a criticism of the design. Moreover, as performances on tasks were skewed towards lower ability, non parametric analysis precluded the method of plotting individual standard scores against the group mean, adopted by Sabbadini et al., (2001). This would then have enabled case study analysis of individual profiles of strengths and weaknesses. As it was, information gained from assessment of each individual child was used in the needs assessment for the new paediatric learning disability service. Nevertheless, the remit of this study was to investigate the usefulness of traditional methods of assessing and diagnosing learning disability, and compare this with a brain and behaviour model. Whilst investigating individual case profiles of ability would also have provided an appropriate methodology for this purpose, the finding that the group as a whole were impaired on attention and executive function, relative to other neuropsychological functions, was still an important and valid confirmation that learning disability may be characterised by specific impairment.

This finding also reflects previous literature, which suggested that people with Down syndrome and cerebral palsy had specific working memory deficits (Vicari, et al., 1995; Hulme amd MacKenzie, 1992; Sabbadini, et al., 2001). Working Memory, and other executive functions, are complex functions that determine how behaviour is expressed (Lezak, 1995). In other words,

it is not what is known, but how this knowledge is applied and used effectively. This basic definition belies the complexity of these functions, however, and executive functions subsume highly complex, multi-domain activities (Goldman-Rakic, 1988). It is therefore possible that different types of executive function are impaired in people with different types of learning disability, which may explain why the participants in the current study were all impaired, despite being of mixed aetiology. Again, further investigation of these issues seems merited.

Another apparent criticism of the study concerned the potential biased sample, where there were many more children with severe learning disability of Full Scale IQ below 50, as opposed to those children with significant learning disability, of Full Scale IQ between 50 and 69 (BPS, 2001). One of the aims of the study would have been to demonstrate that distinguishing these two groups on the basis of organic (specific) versus non-organic (global, cultural-familial) learning disability was inappropriate, and that those people with Full scale IQ above 50 represented the lower end of the normal intellectual spectrum (Plomin, 1999). Despite all participants demonstrating a specific impairment in attention and executive function, suggestive of organic aetiology, the generalisability of the findings for children with 'non-organic' or 'cultural-familial' learning disability was limited, because only four children had IQs above 50. Nevertheless, one of these four participants had a rare metabolic disorder, which was a clear medical cause for his disability, suggesting that for this individual, the organic versus non-organic dichotomy is false.

In sum, this study provided evidence for both global and specific deficit hypotheses of learning disability, and this seemed dependent on the type of methodology used in the investigation. Nevertheless, an interaction between the two may provide a more appropriate account of this phenomenon, and deserves further investigation.

Further Criticisms of the Study

Another potential criticism of the current study was the assessment of a relatively small number of participants. Nevertheless, some of the investigations achieved high effect sizes, with corresponding medium to high power. Similarly, the use of only one sample without a specific control group, could also be seem as a criticism. However, as previously highlighted, using a control group without learning disability would merely confirm that children with learning disability would be more severely impaired (Chapman and Hesketh, 2000). A neuropsychological methodology that enabled the examination of relative cognitive strengths and weaknesses, over and above those typically used in intelligence tests was thought to be a more appropriate. In addition, it was hoped that a battery approach to testing would also help to minimise the effects of fluctuating performance, highlighted by Wishart (1996). Despite this, given appropriate resources, a more robust method would be to use a similar design but compare two or more groups of learning disabled children of different age, or of different aetiology. This might enable further differentiation of the development of specific cognitive deficits, their impact on overall development, and the differentiation of specific cognitive deficits according to specific aetiology.

Given that one main aim of the current study was to show that IQ tests in their current form do not seem to provide reliable or valid measures of function for people with learning disability, it was important to check whether the subtests in the NEPSY battery (Korkman, et al, 1998) were reliable and valid measures also. As discussed, the subtests in the attention and executive domain seemed particularly difficult for participants, suggesting that many had reached floor level. However, the advantage of using a neuropsychological approach is that *relative* strengths and weaknesses are analysed. Thus it was possible to conclude that the participants were differentially impaired on some subtests compared with others. Furthermore, the attention and executive domain of the NEPSY assessed cognitive functions that are sometimes viewed as dissociable, and sometimes not. Certainly, areas such as the parietal lobe are associated with attention, whilst the frontal lobe is often associated with executive function (Lezak, 1995). However, the authors of the NEPSY battery state that factor analytic studies have not yielded conclusive evidence of the subcomponents of attention and executive function (Korkman, et al 1998), and abilities such as planning and monitoring goal directed activity seem to inherently require the ability to focus, maintain and switch attention.

Other observations suggested that in the sensorimotor domain, nine subjects also had particular difficulty in the 'Fingertip Tapping,' subtest, as they found it difficult to sustain the required finger movements, for the required number of trials. Moreover, two subjects in particular, reached floor level in many tests, but were included because they still achieved scores in others. An additional drawback of the NEPSY battery was that the memory and learning domain had a high verbal content (Korkman, et al 1998), so that impairments in language processing may have

contaminated performance. There was also no provision for visual memory and learning. Thus, although the NEPSY battery provided a great deal of useful information that seemed largely reliable, it may be more preferable to use neuropsychology tasks that had achievable scores, even at the lowest ability level. As few such tests exist, if any, designing or adapting neuropsychological tasks, specifically for people with a learning disability is an important priority.

Finally, another potential criticism was that several of the participants were taking prescribed psychoactive medication. One participant was prescribed Methylphenidate for co-morbid ADHD, and one participant with Down syndrome was prescribed Thyroxine, for hypothyroidsim. However, these drugs would be expected to facilitate cognitive performance. In addition, four participants were prescribed anticonvulsants for co-morbid epilepsy. Whilst these may depress overall cognitive function, given the high prevalence of epilepsy in people with learning disability, it is unrealistic to exclude such participants.

Executive Problems or Emotional Difficulty?

In order to investigate whether executive function was directly linked to typical behaviour difficulties found in learning disability, the second hypothesis argued that attention and executive dysfunction would correlate with behaviour problem scores, measured using the Developmental Behaviour Checklist (Einfeld et al, 1992). Specifically, it was thought that disruptive behaviour and self-absorbed behaviour would be associated with attention and executive function, because

these behaviours seemed to be most closely associated with problems such as behaviour disregulation, lack of initiation and poor self control often associated with executive dysfunction.

There was some limited evidence for this hypothesis. Behaviour problems were found to be unequivocally independent of performance in sensorimotor function; visuospatial function; memory and learning; and language function. In addition, when age level was considered, performance in attention and executive function was not associated with either general behaviour difficulties, or specific disruptive or self-absorbed behaviour problems. Thus, it seemed that the types of problems measured using the Developmental Behaviour Checklist (Einfeld, et al 1992) were independent of neuropsychological function.

However, when attention and executive function was analysed, irrespective of stage of development, correlation with general behaviour problems, as well as self absorbed behaviour, just failed to reach the conservative estimate of significance. Furthermore, the influence of attention and executive function accounted for 19.4% of the variance in total behaviour scores, and 17.6% of the variance in self-absorbed behaviour, suggesting a medium effect size and moderate power (Clark-Carter, 1997; Bissonnette, 2000)). This provided limited and tenuous evidence that executive function may underpin some behaviour problems associated with learning disability, and so merits further investigation. In addition, this seems worth pursuing, given that management of behaviour problems may well be different, if the behaviour problem under consideration was found to have a neuropsychological basis, as opposed to being a functional reaction to circumstances.

The differential diagnosis of organic versus non organic behaviour difficulties is particularly highlighted in people with Down syndrome and dementia. Crayton and Oliver (1983) point out that behaviour difficulties may be misinterpreted as part of the normal presentation of a person with Down syndrome, rather than to developing dementia. This is perhaps because attention and executive function may be a pre-existing impairment in people with learning disability, as the current study suggests, and so would be masked in the development of dementia. Investigation into more sensitive ways of assessing changes in executive function is currently been undertaken, (e.g. Hon, et al, 1999). In addition, recent evidence suggests that people with mild learning disability have a higher point prevalence of schizophrenia, relative to non learning disabled people (Doody, Johnstone, Sanderson, Cunningham Owens, and Muir, 1998). Thus, further investigation into attention and executive function and co-morbid behaviour problems would be helpful, given the association between schizophrenia and executive dysfunction (Frith, 1992).

It was predicted that both self absorbed behaviour and disruptive behaviour would correlate with attention and executive function. However, the trend for a relationship between self absorbed behaviour and attention and executive function, but not disruptive behaviour found in the current study may reflect the level of disability in the particular sample of participants, as Einfeld, et al (1992) also found that people with more severe levels of disability tended to show more self absorbed behaviour. Thus, an improvement for future research would be to assess sufficient numbers of children to enable parametric analyses such as multiple regression. In this

way, the interaction between different types of behaviour, and their impact on different cognitive functions, specific aetiology, as well as IQ would be possible.

Finally, the prevalence of behaviour disorder in this group was higher than average, according to Einfeld, et al (1992). Again, the small and skewed sample number may have contributed to this difference, and precluded further analysis of the impact this had on the second hypothesis. Nevertheless, it was an important finding for the learning disability service needs assessment.

In sum, given that there was some association between self absorbed behaviour and attention and executive function, irrespective of developmental stage, further investigation would provide a better understanding of the complex interactions of brain and behaviour in people with learning disability.

CONCLUSION

The findings of this study provide further support for the inadequacy of the IQ test. Current methods of assessment, based on an IQ quotient, do not seem to be reliable. In addition, an IQ quotient does not provide a valid account of the actual phenomenon of learning disability. Instead, IQ can only provide an inaccurate means of classifying those with and those without learning disability. The reason for this use of IQ is mainly historical, and has potentially led to the circular argument that using a global measure of performance means that people with learning disability are globally impaired. In contrast, a neuropsychological, or brain and behaviour framework, has the potential for delineating a wider range of cognitive and behavioural strengths and weaknesses, over and above general intellectual ability. This may therefore provide a more reliable and valid method of diagnosing specific cognitive impairment in learning disability, and may also be more clinically useful in identifying areas for clinical intervention. Finally, this seems especially important in the assessment of children with learning disability, given that early intervention may help to modify some of their difficulties.

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APPENDIX ONE

LOTHIAN RESEARCH ETHICS COMMITTEE

CERTIFICATE OF ETHICAL REVIEW

LREC Reference Number: LREC/2000/7/32
Title: Using a comprehensive neuropsychological, behavioural and psychiatric assessment to investigate the relationship between brain and behaviour in paediatric learning disability
Researcher: Dr Emma McLellan-Brown

The Psychiatry/Clinical Psychology Research Ethics Sub-Committee reviewed this proposed study and has agreed that it is ethical and appropriate to be carried out in the Lothian Area. This opinion encompasses all aspects of the application including the Patient/Subject Information Sheet and all other accompanying documentation provided.

The date of the meeting and the members present are shown on the attached sheet.

It is a condition of this opinion that you **must** obtain appropriate management approval from the relevant NHS body under the auspices of which the research is intended to take place **before** starting the study. It is that NHS body which has the responsibility of deciding whether or not the research should go ahead taking account of the advice of the Local Research Ethics Committee. It is also a condition that you are required to notify the Psychiatry/Clinical Psychology Research Ethics Sub-Committee, in advance, of any significant proposed deviation from the original protocol or application form. Reports to the Sub-Committee are also required once the research is underway if there are any unusual or unexpected results which raise questions about the safety of the research.

Researchers are also required to report on success, or difficulties, in recruiting subjects in order to provide useful feedback on perceptions of the project among patients and volunteers.

Peter Reith
Secretary
Lothian Research Ethics Committee

Annette Harris
Administrator
Psychiatry/Clinical Psychology
Research Ethics Sub-Committee

The Psychiatry/Clinical Psychology Research Ethics Sub-Committee is fully compliant with the International Committee on Harmonisation/Good Clinical Practice (ICH) Guidelines for the Conduct of Trials Involving the Participation of Human Subjects as they relate to the responsibilities, composition, function, operations and records of an Independent Ethics Committee/Independent Review Board. To this end it undertakes to adhere as far as is consistent with its Standing Orders, to the relevant clauses of the ICH Harmonised Tripartite Guideline for Good Clinical Practice, adopted by the Commission of the European Union on 17 January 1997. The Membership List, Standing Orders and Statement of Compliance were included on the computer disk containing the guidelines and application form and are available on request.

Dear Parent / Guardian

We are part of the Child and Family Mental Health Department, ****. Together with **** School we are carrying out a project to look at ways of assessing children with learning disability. We are particularly interested in looking at the relationship between a child's strengths and weaknesses in learning, adaptive behaviour, psychological and psychiatric well-being.

We are hoping to assess a large group of primary school children, and your child is being invited to take part in the research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the enclosed information sheet carefully and talk it through with friends, relatives and your GP if you wish. You could arrange an interview with Emma McLellan - Brown if you would like more information, or telephone us if there is anything that is not clear. Take time to decide whether or not you would like your child to take part.

If you do decide that you would like your child to take part, please keep the information sheet, and sign and return the tear off slip at the bottom of this page in the stamped addressed envelope. Please also tick the box if you would like a summary of your child's assessment (available September 2001). A copy of this page is included for you to keep.

Yours sincerely,

Emma McLellan – Brown,
Trainee Clinical Psychologist
(Main Researcher)

Mrs **** Head Teacher,
**** School

Mr ****
Consultant Clinical Neuropsychologist

Dr ****
Consultant Psychiatrist

✂

	Consent Required	**Please Tick ✓**
1	I / we have read and understood the information sheet, and I am ready for my child to take part in this study.	
2	I / we understand that I can withdraw this consent at any time, without giving any reason.	
3	I / we understand that sections of my child's medical notes and school records may be looked at by Emma McLellan - Brown, where it is relevant to my child's participation. I/ we give permission for Emma McLellan - Brown to have access to my child's records.	
4	I/ we give permission for the results to be used by the school to help in the care of my child.	
5	I/ we give permission for my G.P. to be notified of my child's participation in this study.	
6	I / we would like an interview with Emma McLellan – Brown.	
	Optional Consent	
7	I / we would like to have a summary of my child's results.	
8	I / we would like to have an interview with the main researcher – Emma McLellan – Brown.	

Print Name.....Signed.....

INFORMATION SHEET

1. Study title

Comprehensive Assessment of Children with Learning Disability

2. What is the purpose of the study?

Children with Learning Disabilities can have very complex needs. They might have difficulties in communication, attention and concentration, and learning new information. They may also have difficulties in controlling their behaviour. These things can also make it very difficult to find out why they are feeling upset or distressed. These are the reasons why we are trying to find more accurate ways of assessing learning disabled children's needs. The findings will also help us to plan psychological care for other children in the future.

3. What will your child have to do?

The assessment will be done in several 20-minute sessions, and will take place over 2 - 3 school days. Testing will take place at **** School through the school day, and your child will be taken out of their normal class for short periods.

The assessments will involve questions and answers, paper and pencil exercises, and puzzles such as making patterns from blocks. This will look at the different ways that learning disability can affect how children take in information, concentrate, learn and remember, and work things out. We will then try to see if there is a link between these functions, behaviour problems and emotional upset.

A report of your child's results can be sent to you. However, because of the way the study is done, this can only be sent out when all children have been tested. Reports will therefore be available in September 2001.

4. Why has your child been chosen?

A group of children have been chosen from **** School, to find out whether this way of assessing their needs will be more useful. A sample of children aged 7 - 13 have been chosen.

It is up to you to decide whether or not you want your child to take part. If you decide that your child can take part you are still free to withdraw at any time and without giving a reason. This will not affect the standard of care that your child receives at school. The same applies if you decide that you do not want your child to take part at all.

5. Will my child's participation in this study be kept confidential?

All information collected about your child during the research will be kept strictly confidential. Any information about your child will have their name and address removed so that your child cannot be recognised from it. Information from your child's medical records will be required for purposes of analysing the results.

6. What will happen to the results of the research study?

The results of the research are likely to be published in approximately 18 months time. You will be notified by Mrs ****, Head Teacher, where you can obtain a copy of the published results. Your child will not be identified in any publication.

With your permission, any results of assessment will be used to inform the teachers at school on how best to care for your child.

With your permission, your child's GP will be notified of their participation in the trial.

7. Who is organising the research?

The research is being done by Emma McLellan – Brown, trainee clinical psychologist, as part of the Edinburgh University Clinical Psychology Training course requirements. She is being supervised by Dr ****, Consultant Psychiatrist at ****. This study has been reviewed by the Psychiatry and Clinical Psychology Research Ethics Sub-Committee.

8. Contact for further information

If you would like to discuss any of the points raised in this sheet, or your have any questions about the research project you can contact:

****

9. Local independent adviser

If required you can also contact Dr ****, Chartered Clinical Psychologist, as an independent adviser, to discuss any questions. She can be contacted at the following address:

****

Thank you for reading this and for your consideration

APPENDIX TWO

WISC-III-UK (Wechsler, 1992)

Test Characteristics

The WISC-III-UK is an individually administered clinical instrument for children aged from 6 years to 16 years and 11 months. It is the third revision of the original scale, and has been revised because of the need to update norms due to IQ drift; to enhance the factor structure; and to improve the subtest content, ease of administration and rules for scoring (WISC-III-UK manual, 1992). The materials have also been updated and made more visually interesting for children (WISC-III-UK manual, 1992). There are thirteen subtests. These divide into verbal tests, which require language based information processing, and performance tests, which require non-verbal information processing. These subtests are described in more detail in Table A.1. Test materials are packaged in a brief case, and include a manual, record form booklets, cards, blocks and puzzles.

Responses on the subtests are first recorded as raw scores. These are then converted to scaled scores, derived from standardised normative values, found in the manual appendices. Three composite scores can then be derived from the scaled scores. The sum of the scaled scores on the verbal subtests gives Verbal IQ (VIQ), the sum of the scaled scores on the Performance subtests gives Performance IQ (PIQ), and the sum of all scaled scores gives the Full Scale IQ (FIQ). Scaling the scores in this way allows for the use of a mean of 100, and standard deviation of 15.

Table A.1: Descriptions of the WISC-III-UK subtests, (adapted from Wechsler, 1992)

WISC – III – UK Subtest	**Description**
Verbal Scale	
Information	A series of orally presented questions that tap the child's knowledge about common events, objects places, and people.
Similarities	A series of orally presented pairs of words for which the child explains the similarity of everyday objects or concepts they represent.
Arithmetic	A series of arithmetic problems which the child solves mentally and responds to orally.
Vocabulary	A series of words presented orally which the child defines.
Comprehension	A series of orally presented questions which require the child to solve everyday problems or to show understanding of social rules and concepts.
Digit Span[a]	A series of orally presented number sequences which the child repeats verbatim fro Digits Forward and in reverse order for Digits Backward.
Performance Scale	
Picture Completion	A set of colourful pictures of common objects and scenes of which is missing an important part which the child identifies.
Coding	A series of simple shapes (Coding A) or numbers (Coding B) each paired with a simple symbol. The child draws the symbol in its corresponding shape (Coding A) or under its corresponding number (Coding B), according to a key. Coding A and B are included on a single perforated sheet in the Record Form.
Picture Arrangement	A set of colourful pictures, presented in mixed-up order, which rearranges into a logical story sequence.
Block Design	A set of modelled or printed two-dimensional geometric patterns which the child replicates using two-colour cubes.
Object Assembly	A set of jig-saw puzzles of common objects, each presented in a standardised configuration, which the child assembles to form a meaningful whole.
	Continued
Symbol Search[b]	A series of paired groups of symbols, each pair consisting of a target group and a search group. The child scans the two groups and indicates whether or not a target symbol appears in the search group. Both levels of the

	subtest are included in a single response booklet.
Mazes[a]	A set of increasingly difficult mazes, printed in a response booklet, which the child solves with a pencil.

[a]Supplementary subtest
[b]Optional subtest

Four factor based index scores can also be derived, and these factors also follow the standard pattern of a mean of 100, and standard deviation of 15. Verbal Comprehension (VCI) is derived from the Information, Similarities, Vocabulary, and Comprehension subtests; Perceptual Organisation (POI) is derived from the Picture Completion, Picture Arrangement, Block Design and Object Assembly subtests; Freedom from Distractibility (FDI) is derived from the Arithmetic and Digit Span subtests, and Processing Speed (PSI) is derived from the Coding and Symbol Search subtests. The supplementary subtest Digit Span and optional subtest Symbol Search were therefore administered, so that calculation of all four factor based indexes would be possible. However, it was felt unnecessary to administer the Mazes subtest.

Psychometric Properties

Full details of psychometric properties are available in the WISC-III-UK Manual (Wechsler, 1992), but the following provides a summary.

Reliability

Internal Stability- WISC-III-UK norm tables are based on a UK sample of scores, from 824 test administrations. This represents 37 boys and 37 girls for each of the 11 age groups ranging from 6 to 16 years. The sample group closely approximates the same stratification pattern used in the UK Census data, for socio-economic status; geographical region; urban / suburban/ rural

distribution; race/ ethnicity; and gender. However, reliability and standard errors of measurement used to interpret WISC-III-UK scores are derived from the larger US study, based on 2200 administrations of the test. There is a close correspondence between means and standard deviations for subtest raw scores, across each age band, from both the UK and US administrations. The U.S. sample consisted of 100 boys and 100 girls in each age group. Ethnicity, geographic region and parent education were stratified in a similar way to the 1988 US Census Survey. No children with learning disability were included in this sample, although 3% had specific learning difficulties, and 3% were classified as either emotionally disturbed, physically impaired, were in special education, or had other medical problems.

The split half method of establishing reliability was used for each subtest except Coding and Symbol Search. Two hundred children, for each age group, ranging from six to sixteen were tested. Individual subtest reliability coefficients, using Spearman-Brown correlation, ranged from 0.65 to 0.92. Average correlations across all age groups ranged from 0.7 to 0.8. The average standard error of measurement across all age groups for this population, varied between 1.17 and 1.67 for individual subtests. For the three IQ scales, it varied between 3.2 and 4.54, and for the four factor indexes varied between 3.78 and 5.83.

For the Coding and Symbol Search subtests, raw score test-re-test correlations were obtained for six age groups, (ages 6, 7, 10, 11, 14, and 15) with 60 children in each age group tested twice. Here correlations for individual age groups, ranged from 0.69 to 0.9, with an average of 0.79 across all age groups tested for Coding, and an average of 0.76 for all age groups tested on Symbol Search. This method had to be used for these two subtests, because it

would not be possible to split speed-based tests into two equivalent halves. For the three IQ scales, reliability coefficients were computed using a formula for the reliability of a composite of several tests. These were above 0.9. Similar tests on the four factor indexes showed coefficients above 0.8.

Stability over time - A separate study was used to investigate test-re-test stability, using 353 children from six age groups of 6, 7, 10, 11, 14 and 15 years. Children were tested on two separate intervals, ranging from 12 to 63 days, median 23 days. Individual subtest reliability showed correlations of 0.66 to 0.82; with correlation of 0.86 to 0.92 for the three IQ scales; and 0.74 to 0.89 for the four factor indexes. Whilst there is an increase of approximately 7-8 points for the Full Scale IQ score, these are felt to be due to practice effects. In sum, both split-half and test-re-test reliability estimates are generally considered very good to excellent (Compendium of Neuro Tests). Inter-scorer agreement was also found to be good, with correlations averaging above 0.9 (Wechsler, 1992).

Validity

Construct Validity - In terms of construct validity, there has been an accumulation of evidence that global intelligence is a construct that is related to criteria such as academic achievement and occupational status, and Full Scale IQ (FSIQ) is the most direct measure of 'g' in the WISC-R (Wechsler, 1992; Kaufman, 1975). This robust finding seems counterintuitive to the main themes of this study. However the issue is not whether intelligence is a unitary concept, but whether current methods to assess intelligence in learning disabled people are reliable and valid, and whether 'g' is a valid and reliable measure of a person's overall neuropsychological function. The

WISC-III-UK therefore has acceptable construct validity in terms of its ability to measure intelligence in most people.

Criterion Validity - Criterion validity studies show that there is also a substantial correlation of approximately 0.5 to 0.8 between IQ measured on Wechsler scales and other measures of intellectual ability (Compendium). The WISC-III-UK manual also cites numerous studies to establish concurrent validity of the previous test edition of the WISC-R, reporting inter-correlations of above 0.75 for VIQ; above 0.55 for PIQ; and above 0.65 for FSIQ (Wechlser, 1992, p75). Predictive validity of between 0.78 and 0.94 is also reported (Wechlser, 1992). Validity studies with the WISC-III-UK also confirm good criterion validity. A sample of 206 children, aged six to sixteen years were tested on both the WISC-R and WISC-III-UK. Time between testing ranged from 12 to 70 days. Inter-correlations for individual subtests ranged from 0.42 to 0.8, and correlations for both measures of VIQ, PIQ and FSIQ were 0.9, 0.81 and 0.89 respectively. The slight decrease in measures of between 2 and 7 points, between the WISC-R and WISC-III, reflect IQ drift. Satisfactory comparisons were also made between the Wechsler Adult Intelligence Scale – Revised (WAIS-R) and WISC-III for 189, 16 year old children, and the Wechsler Pre School and Primary Scale of Intelligence - Revised, (WPPSI – III) for 188, six year old children (Wechsler, 1992).

In terms of internal validity of the WISC-III-UK, the manual shows that all of the subtests correlate positively with each other, suggesting that each subtest measures a related construct. Verbal subtests tend to correlate more highly with each other than with Performance subtests. Similarly, Performance subtests correlate more highly with each other than with Verbal subtests.

This suggests that there are two related underlying factors of verbal and non-verbal intelligence. Further analyses has also suggested four identifiable factors relating to the Verbal comprehension, Perceptual organisation, Freedom from Distractibility, and Processing Speed Indexes (Wechsler, 1992).

NEPSY Neuropsychological Battery (Korkman, et al., 1998)

Psychometric Properties

Reliability

Internal stability - The main sample used in standardising the NEPSY, comprised of 2000 children, with 200 in each age group of 3 to 12 years. Reliability was established using split-half, test-re-test and generalisability methods, depending on the type of subtest. The Tower, Phonological Processing, Comprehension of Instructions, Imitating Hand Positions, Design Copying, Arrows, Memory for Faces, Memory for Names, and Narrative Memory subtests were assessed using split half techniques, based on the Pearson correlation coefficient. Coefficients for ages 5-12 ranged from 0.71 to 0.91. A generalisability coefficient was used to calculate reliability of the Visual Attention, Speeded Naming and Visuomotor Precision subtests, because these subtests incorporate both a speed and accuracy component. Correlations were 0.81, 0.74 and 0.68 respectively.

For the Auditory Attention and Response Set and Fingertip Tapping subtests, test-re-test method was used because of the dependence on speed of performance. For this study, the

sample comprised of a group of 168 American children, with five age groups of 3-4 years (n = 30); 5-6 years (n = 33); 7-8 years (n = 31); 9-10 years (n = 41); and 11-12 years (n = 33). In terms of ethnicity, 74 % were white, which is comparable to U.S. census data. Parent education level was stratified so that 14% completed 11 years of education; 65% completed 12-15 years of education; and 21% completed 16 years of education or more. The sample also comprised 49% boys and 51% girls. The interval between testing ranged from 2 to 10 weeks. The average inter-correlation for Auditory Attention and Response Set, across all ages was 0.82, and was 0.71 for Fingertip Tapping.

Reliability coefficients for the composite Domain Scores ranged from 0.79 to 0.87. The majority of these coefficients therefore meet adequate criteria (Kline, 1993; as cited in Clark Carter, 1999), and so has adequate internal consistency. Standard errors of measurement were also calculated, and these ranged from 5.43 to 7.14 for the composite core domains.

Stability over time - The sample used to establish internal consistency for Auditory Attention and Response Set, and Fingertip Tapping was used to establish stability over time, for all other subtests of the NEPSY. Inter-correlations, using Pearson Correlation, for Domain scores ranged from 0.68 to 0.9. Small, but non-significant improvements in performance were noted for the second assessment, and interpreted as practice effects.

To assess inter-rater reliability, a sample of 50 cases were randomly selected from the main standardisation sample. Intraclass correlations (Shrout and Fleiss, 1979; as cited in Korkman, et al, 1998) showed an overall interrater reliability of 0.99.

Validity

Construct Validity - The first version of the NEPSY was originally published in Finnish, in 1988, although most of the subtests in this version correspond to the current version published in English in 1998. The content of the NEPSY is partly based on Luria's theoretical ideas of neuropsychology where neuropsychological function is made up of inter-related components, each with the potential to influence each other (Korkman, et al., 1998). Other information used as the basis for the scale included "research into executive function, attention and concentration, memory and learning, visuospatial abilities and sensorimotor function in children and adults, brain-behaviour relationships, and the impact of neurological disease (e.g. temporal lobe epilepsy, traumatic brain injury, brain tumour, cerebral vascular disease, and degenerative diseases) on neuropsychological performance." (Korkman, et al, 1998, p195). The NEPSY has also been reviewed for content and bias on two occasions by American expert panels, including paediatric neuropsychologists and school psychologists.

Internal Validity - The degree of relationship among the subtests measuring similar constructs was assessed by correlating each subtest with all other subtests, and with Domain scores (corrected by removing the relevant subtest score to prevent inflated correlations). Correlations for children between 5 and 12 years, were all positive, and in the low to moderate range. This would be expected in the non-clinical standardisation sample, where some subtests such as measures of language functioning tend to relate more strongly to other areas of functioning than others. For instance, the highest correlations occurred between Language and Memory and Learning, and Language and Attention/ Executive Function. In addition, subtests within Domains are more

highly correlated than across domains. This confirms that the domains are testing the purported separate but related cognitive domains.

Criterion Validity - In terms of construct validity, the NEPSY assessment was compared with measures of general intellectual ability, achievement and academic performance, and neuropsychological functioning. Findings from fifteen studies are detailed in the manual, including comparison studies with the WISC-III-UK; the Wechsler Individual Achievement Test; Benton Neuropsychological Tests; and the Children's Memory Scale.

To summarise, the NEPSY shows evidence of convergent and discriminant validity. For instance, there was a moderate relation between intellectual ability and NEPSY performance. Performance on the NEPSY Language domain showed a correlation of 0.62 with Verbal IQ, with a lower correlation of 0.43 for Memory and Learning and Verbal IQ, and 0.20 for Sensorimotor skill and Verbal IQ. These correlations are in keeping with the expected strong relationship between language skills across the two scales, and weaker relationships between memory, motor skill and language. In clinical groups however, these correlations attenuated for specific cognitive functions and intellectual ability. For instance in children with ADHD, the Freedom from Distractibility index from the WISC-III-UK, and the Attention/ Executive Domain of the NEPSY showed a very low correlation of 0.19, compared to 0.35 in the non clinical standardisation group. This was interpreted as evidence that performance patterns for children with specific difficulties differs from non-clinical children, and is further evidence for the dissociation of intelligence from specific cognitive skills. NEPSY performance was also moderately related to school performance. There was also moderate to high correlation with other neuropsychological test similar in content

to NEPSY subtests. For instance there was a correlation of 0.6 for the NEPSY Memory for Faces subtest (immediate presentation) and a similar subtest for the Children's Memory Scale.

Information was also collected from a range of clinical groups, to demonstrate the clinical utility and sensitivity of the scale. The groups included children with ADHD, with and without learning difficulty, specific reading disability, language disorder, autism, fetal alcohol syndrome, traumatic brain injury, and hearing impairment. Korkman, et al (1998) summarise that the core domain scores were differentially sensitive to the expected cognitive problems, that children in these groups would exhibit.

Developmental Behaviour Checklist (Einfeld, et al., 1992)

Psychometric Properties

Content Validity - Items for the scale were derived from reviewing 4500 files of learning disabled children with emotional and behavioural problems. The files came from an assessment clinic in New South Wales, Australia, and the clinic population was regarded as representative of moderately, severely and profoundly learning disabled people, but selective of mild learning disabled people with additional difficulties such as epilepsy or behaviour problems. Of the files, 990 (22%) had been coded for behaviour problems, and 664 of these had sufficient details for further analysis. From the 664 files, 135 descriptions of behaviour problem were recorded. Whilst this was felt sufficient to cover all emotional and behavioural problems, there were a few symptoms of interest that were not represented, such as delusion, thought disorder, and

substance abuse, which were added accordingly. Two psychiatrists reviewed the items, and excluded any that were exclusively related to developmental delay, such as 'no speech', in order to distinguish between organicity and pathology. Two clinical psychologists then rated 200 files using these descriptions. This left 96 descriptions of behaviour, with an average inter-rater item by item agreement on items of 0.68 (Cohen's Kappa) and test-re-test reliability of 0.72 (Cohen's Kappa), (Einfield, et al, 1992). This is considered to show good inter-rater reliability (Robson, 1993; as cited in Clark-Carter, 1999). The items were then checked for overly technical language, and converted to lay descriptions were appropriate. The list was then organised as a checklist, using the same format as the Child Behaviour Checklist (Achenbach and Edelbrock, 1983). This 96 item list formed the Primary Carer version. Items concerning sleep disturbance were removed, and the item "unpopular with other children," was added to form the Teacher version.

Construct Validity - This was demonstrated using the Primary Carer version of the Scale. A sample of 1093 children and adolescents was used, with 665 males, and 438 females. Age ranges were not fully specified, but 165 males and 112 females were below nine years, 141 males and 96 females were between nine and twelve years old, and 349 males and 230 females were over 13 years old. Thirty four percent were profoundly or severely learning disabled; 32% were moderately learning disabled, and 25% mildly learning disabled, with 9% unknown severity.

Cronbach's alpha was used to check internal consistency of the scale. This was reported as 0.94, suggesting that there was no effect on internal consistency when removing any single item. This indicates good internal consistency, so that all items on the scale are measuring a similar construct.

A Prinicipal Component Analysis of both the Teacher and Primary Carer version was conducted. Six factors were identified: 'disruptive,' 'self-absorbed,' 'communication disturbance,' 'anxiety,' autistic related,' and 'antisocial,' and these accounted for 15.6%, 6.2%, 3.6%, 3.0%, 2.6% and 2.3% of the variance, respectively.

Criterion Validity - Concurrent validity was established by comparing DBC scores with clinicians ratings of psychopathology from case records, psychiatric assessment, and other instruments used in behavioural assessment. A random sample of 50 case records was selected, and two experienced psychiatrists assessed degree of psychopathology, using Rutter et al's (1970) concept of psychopathology. Two clinical psychologists then rated the cases using the DBC, and information from the case records. Using Pearson Product Moment Correlation showed a significant correlation of 0.66. A sample of 70 individuals with DBC assessments, were assessed for overall rating of psychopathology by experienced psychiatrists using Rutter et al's (1970) crieteria. They were blind to the DBC assessment score. Using Pearson Product Moment Correlation showed a significant correlation of 0.81. This study also showed that the DBC could discriminate between case and non-case. A sample of 40 subjects, 17 males and 23 females were assessed on the DBC, as well as the Maladaptive Behaviour Section of the AMMR Adaptive Behaviour Scales School Edition (Lambert and Windmiller, 1981) and the total scores from the Problem Behaviour Section of the Scales of Independent Behaviour (SIB, Bruininks, Woodcock and Weatherman, 1984). DBC correlated with the AMMR scale, and SIB scale with Pearson Product Moment Correlations of 0.86 and 0.72 respectively. These studies were felt to show that

the DBC showed adequate validity when compared with alternative measures of emotional and behavioural assessment.

Reliability

Reliability was assessed using inter-rater reliability, and test-re-test reliability.

Internal Stability – A sample of 110 pairs of teachers and teacher's aides were asked to assess children using the Teacher version of the scale, so that one teacher and one teachers aid, assessed a child that they both knew well. Intraclass correlatations were used as these were able to take into account both absolute and relative differences between the scores of two raters, and are a more conservative measure of correlation, (Einfield, 1992). The Intraclass correlation for the Total Behaviour Problem Score was 0.6, and judged as adequate. The authors felt this indicated good reliability, (Einfield, et al., 1992), although Kline suggests a criteria of above 0.7 (Kline, 1993, as cited in Clark-Carter, 1999).

Stability over Time - The Total Behaviour Problem Scores for 13 pupils was assessed on two occasions, completed 2 weeks apart. The pupils ages ranged from 12 to 17 years. Pearson's Product Moment Correlation was used, and showed a test-re-test correlation of 0.6. Again, the authors accepted this as adequate, although Kline recommends a criteria of 0.8 (Kline, 1993, as cited in Clark-Carter, 1999).

DEVELOPMENTAL BEHAVIOUR CHECKLIST

DBC-T (Teacher Version)

Name of Pupil: .....

Date of Birth/Age: .....

Sex: .....

Person Completing Form: ..... **Teacher / Teacher's Aide** (please circle)

Date Completed: .....

Type of School & Class: (please circle) Special School/Special Class in Regular School/Regular Class/Other.....

Level of Disability: mild / moderate / severe / profound / other.....

Is the Pupil: (please circle any that apply) Unable to see/unable to hear Unable to speak/speaks very little

Unable to use arms/legs Subject to other serious medical condition.

Please describe: .....

What programs or activities has the student been unable to participate in due to emotional/behavioural disturbance?

.....

.....

How much time per week/month is the child absent on account of behaviour disturbance?

.....

Of the time the child is in the class, how much is actually spent in productive learning (productive learning could be reduced by, for example, inattention or drowsiness)

(Please circle one)

0	**Most of the time**	**1**	**About 75%**
2	**About 50%**	**3**	**25% or less**

Does the pupil require an equal share of your time compared with other pupils?

Class Time (Please circle one)		**Non face-to-face time (Please circle one)**	
0	**Yes, equal time**	**0**	**Yes, equal time**
1	**Somewhat increased share**	**1**	**Somewhat increased share**
2	**Greatly increased share**	**2**	**Greatly increased share**

Please continue over the page →

Office Use Only

Code No.: ..... Contact Person: .....

	TBPS
Page 2	
Page 3	
Page 4	
Total	

①	②	③	④	⑤	⑥

Below is a list of items that describes pupils. For each item that describes the pupil , now or within the past two months, please circle the **2** if the item is **very true** or **often true**. Circle **1** if the item is **somewhat or sometimes true** of the pupil. If the item is **not true** of the pupil circle the **0**.

0 = not true as far as you know 1 = somewhat or sometimes true 2 = very true or often true

If the pupil is unable to perform an item, circle the **0**. For example, if the pupil has no speech, then for the item "Talks too much or too fast" circle the **0**

Underline any you are particularly concerned about

Office Use Only	Please Circle			
1. ⑤	0	1	2	Appears depressed, downcast or unhappy
2. ⑤	0	1	2	Avoids eye contact. Won't look you straight in the eye.
3. ⑤	0	1	2	Aloof, in his/her own world.
4. ①	0	1	2	Abusive. Swears at others.
5.	0	1	2	Arranges objects or routine in a strict order. Please describe: _____
6. ②	0	1	2	Bangs head.
7. ①	0	1	2	Becomes over-excited.
8.	0	1	2	Bites others.
9.	0	1	2	Cannot attend to one activity for any length of time, poor attention span.
10. ②	0	1	2	Chews or mouths objects, or body parts.
11. ④	0	1	2	Cries easily for no reason, or over small upsets.
12. ④	0	1	2	Covers ears or is distressed when hears particular sounds. Please describe._____
13. ③	0	1	2	Confuses the use of pronouns e.g. uses "you" instead of "I".
14. ②	0	1	2	Deliberately runs away.
15. ③	0	1	2	Delusions: has a firmly held belief or idea that can't possibly be true. Please describe: _____
16. ④	0	1	2	Distressed about being alone.
17. ⑤	0	1	2	Doesn't show affection.
18. ⑤	0	1	2	Doesn't respond to others' feelings, e.g. shows no response if a family member is crying.
19. ④	0	1	2	Easily distracted from his/her task, e.g. by noises.
20.	0	1	2	Easily led by others.
21. ②	0	1	2	Eats non-food items e.g. dirt, grass, soap.
22. ④	0	1	2	Excessively distressed if separated from familiar person.
23. ④	0	1	2	Fears particular things or situations, e.g. the dark or insects. Please describe: _____
24. ⑤	0	1	2	Facial twitches or grimaces.
25. ②	0	1	2	Flicks, taps, twirls objects repeatedly.
26. ④	0	1	2	Fussy eater or has food fads.
27.	0	1	2	Gorges food. Will do anything to get food e.g. takes food out of garbage bins or steals food.
28.	0	1	2	Gets obsessed with an idea or activity. Please describe: _____
29.	0	1	2	Grinds teeth.

Please be sure you have answered all items

Continue next page ➔

Office Use Only

Subscales

TBPS	①	②	③	④	⑤	⑥

0 = not true as far as you know 1 = somewhat or sometimes true 2 = very true or often true
Underline any you are particularly concerned about

Office Use Only	Please Circle			
31. ①	0	1	2	Has temper tantrums, e.g. stamps feet, slams doors.
32.	0	1	2	Hides things.
33. ①②	0	1	2	Hits self or bites self.
34. ④	0	1	2	Hums, whines, grunts, squeals or makes other non-speech noises.
35. ①	0	1	2	Impatient.
36.	0	1	2	Inappropriate sexual activity with another.
37. ①	0	1	2	Impulsive, acts before thinking.
38. ①④	0	1	2	Irritable.
39. ①	0	1	2	Jealous.
40. ①	0	1	2	Kicks, hits others.
41.	0	1	2	Lacks self-confidence, poor self-esteem.
42. ③	0	1	2	Laughs or giggles for no obvious reason.
43. ⑥	0	1	2	Lights fires.
44. ④	0	1	2	Likes to hold or play with an unusual object, e.g. string, twigs; overly fascinated with something, e.g. water. Please describe: _____
45.	0	1	2	Loss of appetite.
46. ②	0	1	2	Masturbates or exposes self in public.
47. ①	0	1	2	Mood changes rapidly for no apparent reason.
48. ⑤	0	1	2	Moves slowly, underactive, does little, e.g. only sits and watches others.
49. ①	0	1	2	Noisy or boisterous.
50. ②	0	1	2	Overactive, restless, unable to sit still.
51.	0	1	2	Overaffectionate.
52.	0	1	2	Overbreathes, vomits, has headaches or complains of being sick for no physical reason.
53. ①	0	1	2	Overly attention-seeking.
54.	0	1	2	Overly interested in looking at, listening to or dismantling mechanical things e.g. lawnmower, vacuum cleaner.
55. ②	0	1	2	Poor sense of danger.
56.	0	1	2	Prefers the company of adults or younger children. Doesn't mix with his/her own age group.
57. ②	0	1	2	Prefers to do things on his/her own. Tends to be a loner.
58.	0	1	2	Preoccupied with only one or two particular interests. Please describe: _____ _____
59. ⑥	0	1	2	Refuses to go to school, activity centre or workplace.
60. ⑤	0	1	2	Repeated movements of hands, body, head or face e.g. handflapping or rocking.
61. ⑤	0	1	2	Resists being cuddled, touched or held.
62. ③	0	1	2	Repeats back what others say like an echo.
63. ③	0	1	2	Repeats the same word or phrase over and over.
64. ②	0	1	2	Smells, tastes, or licks objects.
65. ②	0	1	2	Scratches or picks his/her skin.
	0	1	2	Screams a lot.

Please be sure you have answered all items
Continue over the page →

Office Use Only

TBPS

Subscales

①	②	③	④	⑤	⑥

0 = not true as far as you know 1 = somewhat or sometimes true 2 = very true or often true
Underline any you are particularly concerned about

Office Use Only	Please Circle			
66. ②	0	1	2	Stares at lights or spinning objects.
67. ②	0	1	2	Soils outside toilet though toilet trained. Smears or plays with faeces.
68. ③	0	1	2	Speaks in whispers, high pitched voice, or other unusual tone or rhythm.
69. ②	0	1	2	Switches lights on and off, pours water over and over, or similar repetitive activity. Please describe: _____
70. ⑥	0	1	2	Steals.
71. ①	0	1	2	Stubborn, disobedient or unco-operative.
72. ④	0	1	2	Shy.
73. ②	0	1	2	Strips off clothes or throws away clothes.
74. ①	0	1	2	Says he/she can do things that he/she is not capable of.
75.	0	1	2	Stands too close to others.
76.	0	1	2	Sees, hears, something which isn't there. Hallucinations. Please describe: _____
77. ①	0	1	2	Talks about suicide.
78. ③	0	1	2	Talks too much or too fast.
79. ③	0	1	2	Talks to self or imaginary people or objects
80. ①⑥	0	1	2.	Tells lies.
81. ③	0	1	2	Thoughts are unconnected. Different ideas are jumbled together with meaning difficult to follow.
82. ①④	0	1	2	Tense, anxious, worried.
83. ①②	0	1	2	Throws or breaks objects.
84. ①	0	1	2	Tries to manipulate or provoke others.
85. ③	0	1	2	Underreacts to pain.
86. ③	0	1	2	Unrealistically happy or elated.
87.	0	1	2	Unpopular with other children.
88.	0	1	2	Unusual body movements, posture, or way of walking. Please describe: _____
89. ④	0	1	2	Upset and distressed over small changes in routine or environment. Please describe: _____
90. ②	0	1	2	Urinates outside toilet, although toilet trained.
91. ①	0	1	2	Very bossy.
92. ②	0	1	2	Wanders aimlessly.
93. ①	0	1	2	Whines or complains a lot.
				Please write in any problems the pupil has that were not listed above
	0	1	2	_____
	0	1	2	_____
	0	1	2	_____
94.	0	1	2	Overall, do you feel the pupil has problems with feelings or behaviour, in addition to problems with development? If not, please circle the **0**. If so, but they're minor, please circle the **1.** If they're major problems, please circle the **2**.

Please be sure you have answered all items

Are there any other comments you would like to make?

_____

_____

THANK YOU

_____

Office Use Only

TBPS

Subscales

①	②	③	④	⑤	⑥

APPENDIX THREE

Individual Raw Scores for WISC-III-UK Data

PC	I	CO	S	PA	A	BD	V	OA	CP	SS	DS	
1	17	10	18	5	4	12	4	13	13	12	11	9
2	17	15	29	10	18	12	15	22	14	13	9	8
3	13	3	3	0	0	1	0	4	7	6	1	5
4	8	7	16	9	6	10	6	16	2	14	10	9
5	8	7	19	7	4	12	18	13	8	5	20	13
6	13	6	30	1	16	5	6	3	5	0	6	5
7	8	7	12	9	0	14	6	19	3	6	9	7
8	4	2	5	2	0	1	0	1	2	0	0	3
9	21	7	26	9	27	11	16	12	***22.5***	15	7	9
10	13	8	9	8	3	13	6	17	9	8	5	8
11	8	6	27	1	7	5	6	9	9	5	10	5
12	2	5	29	1	0	2	0	12	13	11	0	4
13	4	1	14	0	0	2	4	2	5	0	0	2
14	9	2	15	0	5	5	10	0	17	2	6	4
15	3	5	14	0	1	3	3	6	3	3	-2	2
16	0	6	6	1	7	1	0	6	3	0	0	6
17	8	9	20	6	7	4	10	8	6	8	0	9
18	11	4	6	6	3	7	6	15	12	7	5	4
19	16	11	18	7	6	15	18	16	17	19	15	11
20	7	7	6	0	4	8	10	9	8	5	1	6
21	11	5	11	8	2	1	12	5	6	11	5	3
22	0	4	0	0	0	0	0	1	26	0	0	6
23	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Raw Scores for WISC-III-UK Data

	VSS	**VIQ**	PSS	**PIQ**	VC	**VCI**	PO	**POI**	FD	**FDI**	PS	**PSI**
1	52		56		40		38		21		29	
2	72		93		60		64		20		38	
3	14		23		13		20		6		4	
4	56		38		46		22		19		26	
5	44		57		32		38		25		39	
6	15		70		10		40		10		36	
7	55		29		41		17		21		21	
8	6		11		5		6		4		5	
9	54		112.5		43		86.5		20		33	
10	54		40		41		31		21		14	
11	26		57		21		30		10		37	
12	31		44		29		15		6		29	
13	5		27		3		13		4		14	
14	9		56		4		41		9		21	
15	17		24		14		10		5		12	
16	14		16		13		10		7		6	
17	35		51		31		31		13		20	
18	39		38		32		32		11		11	
19	68		75		53		57		26		33	
20	29		35		21		29		14		7	
21	30		42		29		31		4		16	
22	5		26		5		26		6		0	
23	0		0		0		0		0		0	
MEAN	31.73913		44.36957		25.47826		29.8913		12.26087		19.6087	
Sdev	21.81371		26.16652		17.43526		19.74034		7.758968		12.86906	
Median	30		40		29		30		10		20	
1st	14		26.5		11.5		16		6		9	
2nd	29.5		39		25		29.5		10		18	
3rd	42.75		54.75		32		31.75		17.75		28.25	
4th	68		112.5		53		86.5		26		39	

Individual Scaled Scores for WISC-III-UK Data

	PC	I	CO	S	PA	A	BD	V	OA	CP	SS	DS
1	6	4	1	1	1	4	1	1	1	3	2	5
2	6	9	4	4	5	3	1	5	2	3	1	4
3	7	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	3	1	1	1	1	1	3	2	5
5	1	5	3	6	1	5	5	4	1	1	11	10
6	2	1	3	1	4	1	1	1	1	1	1	1
7	1	2	1	4	1	6	1	4	1	1	2	3
8	2	2	1	2	1	1	1	1	1	1	1	1
9	9	2	3	4	8	3	2	1	***6***	5	1	5
10	3	3	1	3	1	5	1	3	1	1	1	4
11	4	5	4	1	5	1	3	4	3	2	4	3
12	1	1	2	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	4	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1
16	1	2	1	1	3	1	1	1	1	1	1	3
17	1	3	1	1	1	1	1	1	1	1	1	5
18	2	1	1	1	1	1	1	2	2	1	1	1
19	1	3	1	1	1	5	3	1	2	5	2	5
20	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	7	1	1	2
23	1	1	1	1	1	1	1	1	1	1	1	1

Summary of Scaled Scores for WISC-III-UK Data

	VSS	**VIQ**	PSS	**PIQ**	VC	**VCI**	PO	**POI**	FD	**FDI**	PS	**PSI**	FSS	**FSIQ**
1	13	**58**	10	**52**	9	**59**	9	**54**	9	**68**	3	**52**	23	**51**
2	24	**69**	18	**60**	21	**74**	14	**61**	7	**63**	5	**58**	42	**62**
3	5	**46**	11	**53**	4	**50**	10	**56**	2	**50**	2	**50**	16	**47**
4	9	**54**	5	**46**	8	**57**	4	**50**	6	**60**	3	**52**	14	**46**
5	21	**66**	11	**53**	16	**67**	8	**53**	15	**86**	14	**83**	32	**56**
6	5	**46**	11	**53**	4	**50**	8	**53**	2	**50**	4	**55**	16	**47**
7	17	**62**	5	**46**	11	**61**	4	**50**	9	**68**	3	**52**	22	**50**
8	7	**50**	6	**47**	6	**54**	5	**50**	2	**50**	2	**50**	13	**45**
9	15	**60**	***28***	**70**	12	**78**	***25***	**67**	8	**66**	4	**55**	43	**63**
10	15	**60**	7	**48**	10	**60**	6	**50**	9	**68**	2	**50**	22	**50**
11	13	**58**	19	**61**	12	**62**	15	**62**	4	**55**	8	**66**	32	**56**
12	5	**46**	6	**47**	4	**50**	4	**50**	2	**50**	3	**52**	11	**42**
13	5	**46**	5	**46**	4	**50**	4	**50**	2	**50**	2	**50**	10	**40**
14	5	**46**	8	**49**	4	**50**	7	**51**	2	**50**	2	**50**	13	**45**
15	5	**46**	5	**46**	4	**50**	4	**50**	2	**50**	2	**50**	10	**40**
16	6	**48**	7	**48**	5	**52**	6	**50**	4	**55**	2	**50**	13	**45**
17	7	**50**	5	**46**	6	**54**	4	**50**	6	**60**	2	**50**	12	**44**
18	6	**48**	7	**48**	5	**52**	6	**50**	2	**50**	2	**50**	13	**45**
19	15	**60**	8	**49**	10	**60**	7	**51**	10	**71**	3	**52**	23	**51**
20	5	**46**	5	**46**	4	**50**	4	**50**	2	**50**	2	**50**	10	**40**
21	5	**46**	5	**46**	4	**50**	4	**50**	2	**50**	2	**50**	10	**40**
22	5	**46**	11	**53**	4	**50**	10	**56**	3	**52**	2	**50**	16	**47**
23	5	**46**	5	**46**	4	**50**	4	**50**	2	**50**	2	**50**	10	**40**
MEAN	9.478261	**52.30435**	9.043478	**50.3913**	7.434783	**56.08696**	7.478261	**52.78261**	4.869565	**57.47826**	3.304348	**53.34783**	18.52174	**47.47826**
Sdev	5.853279	**7.540405**	5.716629	**6.095745**	4.58085	**8.067404**	4.97146	**4.689994**	3.646971	**9.774129**	2.720875	**7.450495**	10.00395	**6.686959**
Median	6	48	7	48	5	52	6	50	3	52	2	50	14	46
1st	5	46	5	46	4	50	4	50	2	50	2	50	11.5	43
2nd	6	48	7	48	5	52	6	50	2.5	51	2	50	13.5	45.5
3rd	12.11957	57	10.51087	52.34783	9.5	59.25	7.869565	52.94565	6	60	3	52	21.13043	49.36957
4th	21	66	28	70	16	78	25	67	15	86	14	83	43	63

Individual Raw Scores for NEPSY Data

DC	PP	MF	T	ATT	SN	ARR	MN	FT	VA	CI	IHP	VPP	NM	
1	38	5	25	4	0	9	10	8	81	9	18	19	18	14
2	55	19	30	2	0	15	23	7	61	14	23	21	18	18
3	27	10	8	2	0	1	5	1	138	1	14	5	6	13
4	32	20	22	4	0	14	8	6	74	16	17	12	11	19
5	41	14	14	2	0	0	8	0	300	11	17	5	6	4
6	25	19	14	3	0	2	3	6	70	2	18	16	5	17
7	30	15	12	2	0	21	3	1	180	7	18	8	5	20
8	11	8	16	4	0	0	1	8	300	1	15	6	3	2
9	46	21	26	4	0	24	21	9	82	7	17	14	16	23
10	37	17	11	4	0	5	0	2	90	3	19	13	7	19
11	28	13	23	3	0	1	10	12	110	3	16	13	3	10
12	14	10	17	3	0	28	8	10	84	18	15	14	2	27
13	28	9	12	2	0	2	1	2	300	9	14	8	3	0
14	41	11	27	3	0	6	8	22	105	6	17	9	7	7
15	17	10	15	4	0	31	1	2	125	4	15	5	1	5
16	12	7	9	2	0	1	2	6	300	0	15	7	3	1
17	34	20	14	4	0	7	8	13	75	1	19	13	5	15
18	29	21	17	4	0	3	9	1	300	9	14	9	6	14
19	46	28	26	4	55	14	24	13	95	13	18	20	20	16
20	18	14	10	0	0	2	7	5	300	1	17	1	2	16
21	26	5	6	4	0	9	3	7	300	3	14	3	3	15
22	10	6	0	4	0	0	0	0	300	1	14	6	8	0
23	0	8	5	1	0	0	2	0	300	0	0	5	3	0

Summary of Raw Scores for NEPSY Data

	ATT/EX	LANG	SENSM	VSSP	MANDL
1	13	32	118	48	47
2	16	57	100	78	55
3	3	25	149	32	22
4	20	51	97	40	47
5	13	31	311	49	18
6	5	39	91	28	37
7	9	54	193	33	33
8	5	23	309	12	26
9	11	62	112	67	58
10	7	41	110	37	32
11	6	30	126	38	45
12	21	53	100	22	54
13	11	25	311	29	14
14	9	34	121	49	56
15	8	56	131	18	22
16	2	23	310	14	16
17	5	46	93	42	42
18	13	38	315	38	32
19	72	60	135	70	55
20	1	33	303	25	31
21	7	28	306	29	28
22	5	20	314	10	0
23	1	8	308	2	5
Mean	11.43478	37.78261	194.0435	35.21739	33.69565
StDev	14.29821	14.72461	97.09343	19.22346	16.86156
Median	8	34	135	33	32
1st	5	26.5	111	23.5	22
2nd	8	34	135	33	32
3rd	13	52	308.5	45	47
4th	72	62	315	78	58

Individual Scaled Scores for NEPSY Data

DC	PP	MF	T	ATT	SN	ARR	MN	FT	VA	CI	IHP	VPP	NM	
1	1	1	9	2	1	1	1	2	6	2	1	5	3	3
2	8	3	13	1	1	3	9	2	9	5	8	7	3	5
3	1	1	2	1	1	1	1	1	2	1	1	1	1	3
4	1	3	6	2	1	2	1	1	6	7	1	2	2	5
5	4	4	4	2	1	1	3	1	1	6	4	1	2	1
6	1	3	4	1	1	1	1	1	7	1	1	3	1	4
7	1	2	3	1	1	5	1	1	1	1	1	1	2	6
8	1	4	5	5	1	1	3	5	1	2	4	2	2	1
9	4	3	9	3	1	6	8	2	5	1	1	3	3	7
10	1	2	3	3	1	1	1	1	5	1	1	2	2	5
11	2	6	9	4	1	2	7	7	7	2	4	5	2	4
12	1	1	5	1	1	7	1	2	5	8	1	2	1	10
13	1	1	3	1	1	1	1	1	1	2	1	1	1	1
14	2	1	10	2	1	1	1	8	4	1	1	1	2	1
15	1	1	4	2	1	8	1	1	2	1	1	1	1	1
16	1	1	2	1	1	1	1	2	1	1	1	1	1	1
17	1	3	4	2	1	1	1	3	6	1	1	2	1	3
18	1	3	5	3	1	1	1	1	1	2	1	1	2	3
19	4	7	9	2	5	2	10	3	4	4	1	6	4	4
20	1	1	3	1	1	1	1	1	1	1	1	1	1	4
21	1	1	1	2	1	1	1	2	1	1	1	1	1	3
22	1	1	1	2	1	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Summary of Scaled Scores for NEPSY Data

	ATT/EX		LANG		SENSM		VSSP		MANDL	
1	5	**50**	3	**50**	14	**63**	2	**50**	14	**63**
2	7	**51**	14	**69**	19	**73**	17	**92**	20	**76**
3	3	**50**	3	**50**	4	**50**	2	**50**	6	**50**
4	10	**54**	6	**55**	10	**57**	2	**50**	12	**59**
5	9	**53**	9	**61**	4	**50**	7	**56**	6	**50**
6	3	**50**	5	**53**	11	**58**	2	**50**	9	**54**
7	3	**50**	8	**60**	4	**50**	2	**50**	10	**56**
8	8	**52**	9	**61**	5	**50**	4	**52**	11	**58**
9	5	**50**	10	**63**	11	**58**	12	**73**	18	**71**
10	5	**50**	4	**51**	9	**55**	2	**50**	9	**54**
11	7	**51**	12	**66**	14	**63**	9	**62**	20	**76**
12	10	**54**	9	**61**	8	**54**	2	**50**	17	**69**
13	4	**50**	3	**50**	3	**50**	2	**50**	5	**50**
14	4	**50**	3	**50**	7	**52**	3	**50**	19	**74**
15	4	**50**	10	**63**	4	**50**	2	**50**	6	**50**
16	3	**50**	3	**50**	3	**50**	2	**50**	5	**50**
17	4	**50**	5	**53**	9	**55**	2	**50**	10	**56**
18	6	**50**	5	**53**	4	**50**	2	**50**	9	**54**
19	11	**56**	10	**63**	14	**63**	14	**81**	16	**67**
20	3	**50**	3	**50**	3	**50**	2	**50**	8	**53**
21	4	**50**	3	**50**	3	**50**	2	**50**	6	**50**
22	4	**50**	3	**50**	3	**50**	2	**50**	3	**50**
23	3	**50**	3	**50**	3	**50**	2	**50**	3	**50**
Mean	5.434783	**50.91304**	6.217391	**55.73913**	7.347826	**54.3913**	4.26087	**55.04348**	10.52174	**58.26087**
StDev	2.573044	**1.703287**	3.47663	**6.333299**	4.686622	**6.177225**	4.423259	**11.38771**	5.492719	**9.274684**
Median	4	**50**	5	**53**	5	**50**	2	**50**	9	**54**
1st	3.5	**50**	3	**50**	3.5	**50**	2	**50**	6	**50**
2nd	4	**50**	5	**53**	5	**50**	2	**50**	9	**54**
3rd	7	**51**	9	**61**	10.5	**57.5**	3.5	**51**	15	**65**
4th	11	**56**	14	**69**	19	**73**	17	**92**	20	**76**

Individual Scores and Summary of Scores for DBC

	TBCS	Disruptive	Self-Absorbed	Communication	Anxiety	Social Relating	Antisocial
1	11	2	1	0	1	5	1
2	0	0	0	0	0	0	0
3	4	0	0	0	1	0	0
4	12	5	0	0	2	1	0
5	119	34	17	16	20	14	2
6	34	9	7	2	10	3	0
7	3	1	0	0	2	0	0
8	40	15	12	2	4	0	0
9	39	15	4	5	5	2	3
10	37	16	3	1	4	1	1
11	22	10	1	0	6	3	0
12	7	3	0	0	0	1	3
13	2	0	0	0	1	1	0
14	21	2	5	2	3	2	0
15	22	6	4	1	3	2	1
16	5	0	0	0	1	1	1
17	34	9	4	2	4	9	0
18	3	0	0	0	1	1	0
19	6	3	0	0	0	0	1
20	40	20	5	0	5	6	1
21	34	1	8	3	6	8	0
22	92	14	27	10	7	16	0
23	42	17	4	0	5	2	0
Mean	27.34783	7.913043	4.434782609	1.913043478	3.956522	3.391304348	0.60869565
Sdev	29.05107	8.680768	6.563162257	3.836582801	4.343001	4.438868923	0.94094394
Median	22	5	3	0	3	2	0
1st	5.5	1	0	0	1	1	0
2nd	21	3	1	0	3	1	0
3rd	38	14.5	5	2	5	4	1
4th	119	34	27	16	20	16	3