Chapter

Multivariate Treatment of Dyslexia, Dysgraphia and Dyscalculia

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Abstract

This chapter focuses on the implementation of a response to intervention model for assessment and treatment of dyslexia, dysgraphia and dyscalculia, which is illustrated through a longitudinal case study. The model links learning and adjustment difficulties to multivariate treatment, and through this to firm diagnosis and classification. In applying the model, initial diagnosis of learning disabilities is treated as provisional, based on functional indicators as well as test data. Treatment is then multidimensional, using graded materials that are applied in clinical teaching. The case study shows how firm classification becomes possible through longitudinal assessment and progress evaluation, analysis of response to multivariate intervention as well as response to specific treatment programmes. Diagnosis can then be linked both to concessions and ongoing treatment of areas of functional difficulty in learning and adjustment to school.

Keywords: dyslexia, dysgraphia, dyscalculia, reading, writing, spelling, numeracy, working memory, assessment, evaluation, response to intervention, incremental validity, multivariate treatment

1. Introduction

This chapter provides a longitudinal case study of a dyslexic child (Child H), whose programme included work on a number of fluency-based interventions focused on his difficulties with reading, writing and spelling. Assessment has been based on a response to intervention model (Note 1), linked to treatment using a multivariate approach based on Luria's theories of cerebral organisation [1–4]. In applying the model in working with Child H over a five-year period, labels such dyslexia, dysgraphia or dyscalculia were avoided until such time as treatment programmes had been implemented and Child H was both physically and neurologically mature.

At time of initial assessment, there were a number of different areas in which Child H's reading, writing and spelling were below age level, indicating the need for multivariate treatment. This involved a number of different interventions that were implemented over Child H's years at primary school. In his final year at primary

school, response to intervention assessment was conducted. At this point, a dyslexic label was applied, with a view to motivating for concessions at high school level.

The aim of this chapter is to demonstrate that classification of learning disabilities based on response to intervention is not only possible, but also enhances validity. The case study should be read in conjunction with previous publications in which the approaches and methods used in multivariate assessment and treatment are described in more detail [5–9]. These can be accessed from the publisher free of charge online.

1.1 What is an response to intervention approach to classifying learning difficulties?

The multivariate assessment and treatment programme implemented with Child H follows Luria's theories in conceptualising competencies in reading, writing, spelling and numeracy as hierarchical and based on the development of automaticity [10]. Automaticity in reading, writing and spelling is linked to fluency on both functional and neurological levels [11], and provides a basis for the development of higher-order mental processing. Following Luria, there is thus value in providing fluency-based interventions which can develop basic skills and competences in reading, writing, spelling as well as numeracy, as these can then form a platform on which the scaffolding necessary to develop higher order functions can be built [12–14].

In working with Child H, the aim was to provide this type of functional platform, by focusing on those areas of his functioning in which he had not yet developed competencies based on automaticity. These areas were identified through assessment based on ICD10 linked indicators (Note 2), which enabled Child H's development as well as his difficulties to be described functionally. Functional assessment then enabled labelling to be avoided until such time as Child H had benefit of focused multivariate treatment, and until such time as he was more developmentally and neurologically mature.

As maturation took place, firm diagnosis and classification as dyslexic then became to Child H's benefit, as the classification could be linked both to longitudinal response to interventions as well as to concessions related to his areas of ongoing difficulty. Firm classification of Child H's learning disability could also be based on incremental validity [15–17] as the dyslexic label could be linked both to cross-sectional assessment as well as longitudinal progress evaluation of his response to multivariate treatment using particular types of methods and materials.

1.2 What is the logic of response to intervention classification?

There has been intense debate in the literature on assessment and classification of learning difficulties between those who have advocated or rejected the practice of classifying and labelling different types of reading disabilities, as outlined by Elliott and Grigorenko [18]. The debate is based on a number of issues [19], in terms of which response to intervention classification offers the possibility of more valid evidence-based classification of learning disabilities.

The theoretical basis of the response to intervention model we use has been described by others in the literature [20–23] as well as in a previous publication on our work in this practice [9]. A response to intervention approach to classification of learning disabilities has potential benefits in enabling labelling of learning difficulties to be avoided until such time as there is compelling longitudinal evidence concerning the particular nature of a child's learning difficulties. This can be based both on

assessment and evidence concerning how a child copes with school while being provided with learning support.

There are a number of reasons why response to intervention classification of learning disability is logical. One reason is that there is lack of agreement as to typologies of learning disabilities, as well as to how these apply to children and adults. Another is that there is a lack of consensus as to whether it is better to base diagnosis of learning disabilities on purely functional descriptions of the behaviours associated with how learning disabilities manifest in particular children (using terms such as "backward reading", "specific learning disorder, with impairment in reading" or "specific reading retardation"). A third reason is that there is also concern as to whether it is helpful to apply a label such as "dyslexia", "developmental dyslexia", "dysgraphia" or "dyscalculia" to children for diagnostic purposes, and whether this type of labelling can be prejudicial to children and their families.

In addition, much of the literature is based on the evidence that children's learning difficulties are specific [24–40], indicating that some developmental learning difficulties in children may be built-in and immutable, whilst others may be trainable. Assessment procedures and treatment programmes based on a response to intervention model of classification are thus potentially valuable both to therapists and children [20–22], as they work from the standpoint that classifications of learning difficulties are provisional and emergent until such time as they can be based on treatment validity [41].

On the one hand, this standpoint is based on the belief that it makes more sense scientifically to work from a standpoint that treatment validity is increased if one focuses on the evidence one sees, and if one bases treatment directly on evidence of functioning, as well as the errors made by children. On the other hand, it is based on clinical evidence that it makes more sense to work from diagnoses which have the potential of changing from hypotheses to firm and persistent categories as treatment progresses, based on a process of incremental validity [15, 17]. This is the logic of the case study presented in this chapter.

2. Methodological issues

Unlike my doctoral research which involved an evaluative case study of curriculum development in a programme based on participant observation [42–45], the case study reported in this chapter has been based on a single case (N = 1) design involving longitudinal observation and repeated measurement [46–50]. One purpose has been to implement a changing criterion design to identify the effects of treatments that have been continuously applied as well as varied [51, 52]. Another purpose has been to analyse evidence from a number of indicators to establish gains made over time [49, 53]. A third purpose has been to use common indicators to enable aggregation with the results of other similar N = 1 case studies [54–57].

One limitation is that this case study is based on ex post facto analysis [58, 59]. As human memory is limited and ex post facto analyses are subject to misinterpretation [60–63], a behavioural diary based on a computer-based treatment file supported by longitudinal written file notes has been used to record work done in the sessions worked with the child [64–66]. This activity-based evidence of focuses and types of longitudinal intervention has then been combined with analysis of school reports as well as repeated measurement of outcomes based on use of psychometric testing. The aim has been to link both focuses and sequences of treatment to progress

in a time line recording use of methods and materials focused on the development of basic skills in reading, writing and spelling as well as working memory for both written words and written words in sequence. This type of treatment evidence has then been combined with psychometric testing to enable firm classification of learning disability, based on the suggestions made by Vaughn and Fuchs [21], and Fletcher and Vaughn [22].

As readers may have interests in methods and materials used in treatment, instruments used in assessment as well methods used for evaluation of progress, this chapter describes methods used in treatment, materials used in treatment as well as evidence of outcomes based on longitudinal psychometric testing, using the types of psychometric instruments commonly used in our country as indicators of underlying learning disabilities [6, 7]. Progress and outcomes are then presented descriptively, linked to graphs.

There are many limitations in this type of descriptive case study on a methodological as well as on an inferential level. One limitation is that ex post facto analysis is best suited to description of relationships as opposed to statistical testing of results [60, 62], and for this reason the case study focuses on practical as opposed to statistical significance of test results [67, 68]. Other limitations are implicit in the use of interpretive multimethod analysis and reporting [69, 70], based on evidence from repeated measurement, analysis of trends in school reports as well as visual analysis of graphs of standard scores on psychometric tests [71, 72]. To counter these limitations and increase the likelihood of unbiased and valid interpretation, a colleague has been involved in both the psychometric testing and the analysis of Child H's progress and results [Note 3]. The aim has been to enable data, investigator and time triangulation of longitudinal evidence, based on the suggestions for prolonged engagement and use of multiple data points and multiple investigators made by Denzin [73, 74], and by Guba and Lincoln [75, 76].

Ethically, in addition to parental permission, this case study follows the suggestions made by Yin [59], who has recommended use of pseudonyms for purposes of anonymity in reporting, and the checking of both reporting and interpretation both by participants and by at least one external source [77]. The use of testing and test data would comply with the standards applied by other practitioners working in our country [6], as well as the suggestions for use of response to intervention assessment made by others working internationally [23, 78].

2.1 Classification of particular type of learning disability on the basis of response to intervention: a longitudinal case study

The purpose of the rest of this chapter is to present a longitudinal case study of a single child (Child H), which illustrates the way in which children can be assessed and then taught using a response to intervention approach. Learning difficulties in children are defined as functional difficulties in learning and adjustment to school and conceptualised as multivariate [79–82] requiring a combination of different types of interventions (Note 4).

Initial assessment is thus conducted functionally, with the aim of establishing the child's areas of difficulty. Interventions are then normally longitudinal and conducted side by side with the curriculum taught in the child's school. Firm classification as dyslexic, dysgraphic or dyscalculaic can then be based on evidence which is incremental as well as multimethod, based on a process of both cross-sectional and longitudinal triangulation [83–85].

The model for classification has been described in a previous publication [9], and the aim of the case study provided in this chapter is to provide evidence of how the model can be applied in practice. This will be done through an extended case study of a child with learning difficulty, who has been involved in working with my practice for a number of years. The child's development will be described longitudinally from the time he was first assessed at age nine through to the time of transition from primary school to high school at age thirteen. At this point, based on longitudinal evidence, firm classification as dyslexic was made, linked to concessions in reading, spelling and rate of work.

The model for response to intervention classification of learning disabilities is reflected in **Figure 1** below. It will be noted that the model is multimethod, based on summative assessment linked to progress evaluation of longitudinal interventions conducted across a number of areas of functional difficulty. The model enables incremental validity, based on triangulation across different data points over time [15, 86].

Figure 1.
Classification of learning disabilities based on response to multivariate fluency-based interventions.

In applying the model, firm classification of Child H's learning disability was avoided until such time as there was longitudinal and cumulative evidence concerning his response to the particular methods used in his multivariate treatment programme. At the point of transition from primary school to high school level, classification as dyslexic, dysgraphic or dyscalculaic could be based on both incremental and treatment validities, through analysis of evidence of his response to particular methods, materials as well as teaching techniques. It could also be based on a combination of assessment methods [17, 41].

2.1.1 Child H's background

Child H was at a Model C government school in Grade 3 at time of initial assessment (Note 5). His parents made contact with me in September 2016, indicating that Child H had difficulties with learning which had not been evident at the start of his primary schooling. These started to manifest as he moved from the foundation level into middle school.

As Child H was engaging, cooperative, well-spoken and well mannered, his school reports made no mention of any reading, writing, spelling or learning issues. However, as Child H moved up primary school, his difficulties with reading, writing, spelling and rate of work were increasingly evident to his parents.

There was a family history of learning difficulties. Child H's father had learning problems as a child. Child H's younger brother also had reading, writing and spelling difficulties from the start of his schooling, but overcame these through focused therapy. For these reasons, Child H's parents referred Child H to me for assessment.

2.1.2 Problems highlighted in initial interview and parent questionnaire

- Issues with writing and completing work.
- Spelling and phonic difficulties.
- Difficulties with phonetic spelling.
- Reading fluency difficulties.
- Guessing rather than analysing words, affecting both reading and rate of work.
- Difficulties with completing creative writing tasks.
- Lowered confidence due to awareness of difficulties.
- Familial difficulty (dad had learning difficulties as child; younger brother also had learning difficulties).

2.1.3 Strengths highlighted in initial interview and parent questionnaire

- Social abilities and friendships at school.
- Leadership in scouting and cubs.

- Good visual memory which is used for remembering spelling.
- Good at swimming and other sports.
- Interest in outdoor activities such as fishing.
- Spatial competence as indicated by interests in Lego and computers.

2.1.4 Initial assessment

The following tests were administered in the initial sessions with Child H:

Buck's House Tree Person Test, the Bender Gestalt Test, the Peabody Picture-Language Vocabulary Test, the Schonell One Word Spelling Test, the Holborn Reading Scale and the Schonell Graded Dictation Tests (Tests A and B). These test-based evidences were supplemented by implementation of a set of Phonic Inventories (Note 6) as well as pragmatic language tasks involving (a) analysis of a spontaneous writing sample, (b) analysis of school books and (c) analysis and comprehension of a picture story, as well as an IQ (the WISC IV UK) (**Figure 2**).

2.2 Child H: profile of results from initial testing of basic skills here

Initial testing indicated that Child H had adequate vocabulary for age level, but had one word reading difficulties, sentence reading difficulties, one word spelling difficulties, sequential spelling difficulties and problems with sound/letter associations indicating difficulties with phonics. There were also a number of reversals in writing (e.g. b/d) as well as difficulties with rate of work. Observation indicated that Child H was a very well-mannered and engaging child, but that there was evidence of both attentional and focus difficulties. There were also indicators of under-confidence in Child H's drawings as well as anxiety indicators in the Bender Gestalt Test, suggesting that his attentional difficulties could be linked to performance anxiety.

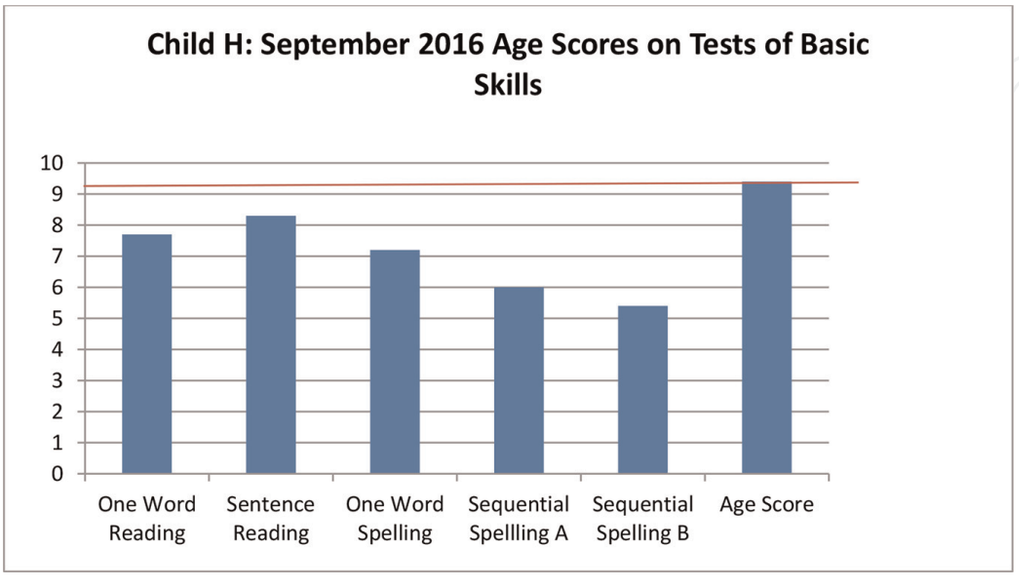

Figure 2.
Child H – profile of results from initial testing of basic skills.

There were a number of indicators of potential learning disability in the case history, as well as evidence of lowered scores in reading, writing and spelling from the two initial sessions conducted with Child H. In addition, there was evidence of phonic errors made on both short and long vowel sounds as well as beginning and ending blends and clusters, slow rate of reading, slow rate of work and spelling errors on pragmatic tasks as well as rate of work difficulties and spelling errors in Child H's schoolwork.

As there was evidence of fluency-based difficulties affecting accuracy and rate of reading, as well as evidence of difficulties with rate and spelling of written work, more in-depth testing was conducted to establish Child H's cognitive profile, as well as testing using the Phonic Inventories [87–90] to establish Child H's patterns of phonic errors. These results are reported below.

2.2.1 Child H's profile on the WISC IV (UK)

Child H's performance on the different subtests of the WISC IV (UK) [91] is summarised in **Table 1**, which presents the profile of standard scores obtained in the

Verbal Comprehension			**Perceptual Reasoning**		
Subtest	**What subtest measures**	**Standard score**	**Subtest**	**What subtest measures**	**Standard score**
Similarities	Verbal abstract reasoning and word finding ability.	14	Block Design	Abstract non-verbal reasoning, spatial perception and organisation.	9
Vocabulary	Ability to explain the meaning of words.	9	Picture Concepts	Abstract ability to analyse and classify pictorial information.	11
Comprehension	Social understanding and judgement.	10	Matrix Reasoning	Non-verbal abstract reasoning and concept formation.	8
	Working Memory			Processing Speed	
Subtest	What subtest measures	Standard Score	Subtest	What subtest measures	Standard score
Digit Span	Short-term auditory memory.	11	Coding	Ability to work at speed in applying a simple code accurately and in sequence.	5
Letter-Number Sequencing	Ability to manipulate letters and numbers sequentially by holding them in short term and working memory.	12	Symbol Search	Ability to work at speed in establishing whether particular symbols are present or absent.	8

Note. In the above table, a standard score is a scaled score relative to a normal curve, where the average score would be a score of 10. Scores higher than 12 indicate above average performance relative to age level, indicating potential areas of cognitive strength. Scores lower than 8 indicate below average performance relative to age level, indicating potential areas of cognitive weakness. This type of profile interpretation needs to be conducted cautiously and substantiated against other information, as any scaled score is subject to measurement error.

Table 1.
Child H – profile of standard scores on WISC IV (UK) (September 2016).

verbal comprehension, perceptual reasoning, working memory and processing speed areas of the test. This was analysed for indicators of strength and weakness in cognitive processing, as well as indicators of the strategies Child H employed in processing information of different types.

2.2.2 Profile of child H on the WISC IV (UK) about here

It was evident from the profile that Child H's performance in all areas of the IQ was in the normal range. However, there was evidence of scatter in level of performance both within and across different areas of the test, indicating that he was likely to have adapted to his difficulties at school using particular learning strategies linked to strengths and weaknesses in how he perceived, processed and remembered information (Note 7). The verbal comprehension scores indicated that Child H had well-developed verbal reasoning ability, and average vocabulary, comprehension, general knowledge and verbal classification abilities relative to age level. The perceptual reasoning side of the test indicated adequately developed perceptual and spatial abilities relative to age level, but weakness in non-verbal reasoning, while the scores in the working memory side indicated good short-term auditory memory as well as good sequential memory for letters and numbers.

There were, however, difficulties in the processing speed areas of the test, with weakness in symbol search and particular weakness in coding. Low scores on the 20 coding test of the WISC are often associated with difficulties in reading and spelling [92–95]. Combined with low scores in symbol search, this indicated difficulties with rate of processing symbolic information, as well as difficulties in coding information as well as recoding information from memory.

Overall the IQ profile provided evidence of scatter in the test scores indicative of strengths and weaknesses in particular types of cognitive and language processing. This will be evident from the graph presented below, in which the standard scores on the test are grouped by cognitive area (**Figure 3**).

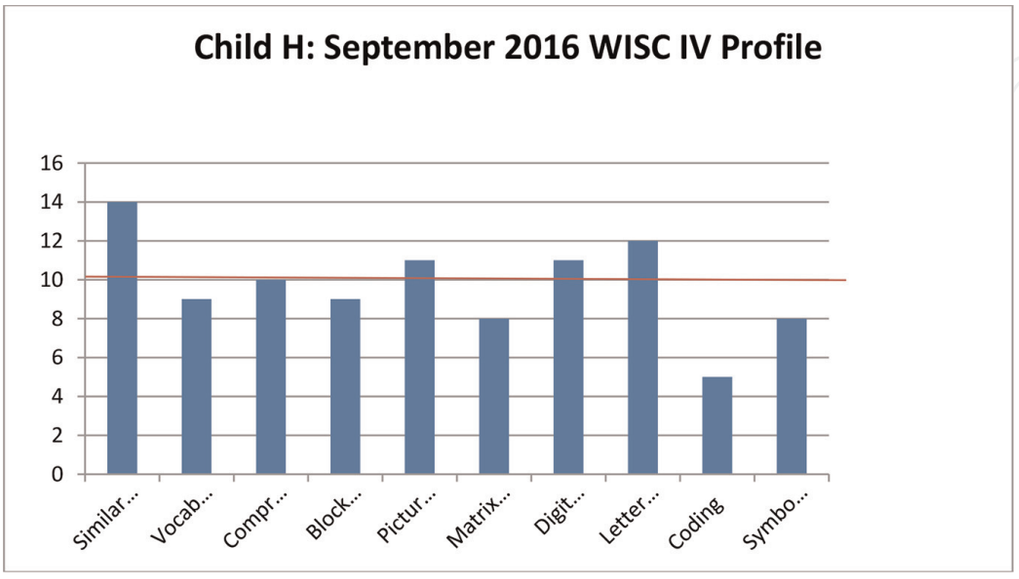

Figure 3.
Child H – profile of standard scores on WISC IV (UK) (September 2016) grouped by cognitive area.

2.2.3 Child H profile of standard scores on WISC IV (UK) (September 2016) grouped by cognitive area here

Overall, the indications from the profile were that Child H had particular strengths in verbal reasoning and working memory, but weaknesses affecting perceptual development as well as processing speed. Coding was a particular area of difficulty indicating needs for intervention in developing sequential working memory for words. There were also indications from the IQ that Child H's strengths in other working memory areas could be used as the basis for interventions to improve his functioning in writing and spelling.

2.2.4 Child H's profile on the phonic inventories

As Child H was in Grade 3 at school, the first of the three levels of the Phonic Inventories were also administered, and error analysis conducted. Child H's profile indicated high error scores on:

- Beginning consonant blends.
- Ending consonant blends.
- Medial vowels in words based on short vowel sounds.

Overall, Child H's pattern of errors on the phonic inventories provided indicators of both phonological and phonic difficulties. A high incidence of errors on ending consonant blends on this instrument [96–98] is associated with learning disabilities. Number of medial vowel errors is also an indicator of learning disability both in primary school age children [99, 100] and in high school children [101].

The profile of errors on the instrument was thus used as corroborating evidence of the presence of a learning disability, while also providing evidence of specific areas of learning need. In addition, the profile was analysed to identify specific phonic errors and error types which could be targeted for instruction [102–104].

3. Functional classification of child H's learning difficulties

The conclusion was that the tests of basic reading, writing and spelling skills fell well below what would be expected in terms of age level as well as Child H's overall level of cognitive performance, enabling diagnosis of a reading disorder under DSM-IV code 315.00 (Note 8), as well as a disorder of written expression in terms of the diagnostic criteria for DSM-IV code 315.2 (Note 9). As there were also attentional and focus difficulties possibly linked to anxiety and emotionality around school performance or to neurological immaturity or to a combination of both physiological and emotional factors, an additional ICD10 classification of Z 73.3 (Stress, not elsewhere classified) could be applied in working with Child C.

Based on the results from assessment, Child H was thus classified for medical aid purposes as having developmental learning difficulties affecting a number of areas of scholastic functioning. The classification provided was functional, based on the use of ICD10 indicators linked to the presence of a number of areas of difficulty, as

presented in **Tables 2** and **3** below. This was done to avoid labelling Child H as either dyslexic or dysgraphic until such time as the different types of intervention in his programme had been implemented.

3.1 Child H—areas of functional difficulty identified in initial assessment here

3.1.1 Child H—linking areas of assessment with focuses of treatment here

The steps summarised in **Table 2** and **3** were taken in order to ensure that the ICD10 indicators would be linked to different areas and different types of intervention in a multivariate treatment programme. If Child H's learning difficulties

Sources of Evidence			**Areas of Difficulty**
Initial Interview		###	Oral Reading Fluency
Child and Family History		###	Silent Reading
Previous Assessments and School Reports		###	Phonic Analysis and Synthesis
Scholastic Testing		###	Oral Reading Comprehension
Cognitive Testing		###	Silent Reading Comprehension
	Verbal Processing		Oral Language Expression
	Non-verbal Processing	###	Written Language Expression
	Dimensions of Working Memory	###	Working Memory: Single Words
	Processing Speed	###	Working Memory: Words in
	Sequence		
Potential Mediating Variables			Number Concepts
###	Focus and Attentional Indicators		Arithmetic Processes
###	Indications of Hyperactivity	###	Reading of story sums
	Auditory Processing Indicators	###	Comprehension of story sums
	Indicators of Phonological Difficulties		Units of Measurement
###	Indicators of Phonic Difficulties		Dates and Time
###	Visual processing indicators		Fractionation
###	Emotional or anxiety factors	###	Maths problem-solving

Key: ### Indicators linked to ICD 10 Descriptors Present.

Table 2.
Child H – areas of functional difficulty identified in initial assessment.

Sources of Evidence			**Focuses of Treatment**	
Initial Interview		###	Oral Reading Fluency	
Child and Family History		###	Silent Reading	
Previous Assessments and School Reports		###	Phonic Analysis and Synthesis	
Scholastic Testing		###	Oral Reading Comprehension	
Cognitive Testing		###	Silent Reading Comprehension	
	Verbal Processing		Oral Language Expression	
	Non-verbal Processing	###	Written Language Expression	
	Dimensions of Working Memory	###	Working Memory: Single Words	
	Processing Speed	###	Working Memory: Words in sequence	
Identification of Mediating Variables			Number Concepts	
###	Focus and Attentional Indicators		Arithmetic Processes	
###	Indications of Hyperactivity		###	Reading of story sums
	Auditory Processing Indicators		###	Comprehension of story sums
	Indicators of Phonological Difficulties		Units of Measurement	
###	Indicators of Phonic Difficulties			Dates and Time
###	Visual processing indicators			Fractionation
###	Emotional or anxiety factors		###	Maths problem-solving

Key: ### Indicators linked to ICD 10 Descriptors Present.

Table 3.
Child H – linking areas of assessment with focuses of treatment.

persisted, firm classification as learning disabled could then be based not only on cross-sectional psychometric testing, but also on evidence from gain scores (Note 10) linked to progress evaluation of Child H's response to the interventions in his programme.

Progress evaluation would thus be based on the one hand to analysis of the continuing low areas in his assessment, and on the other to Child H's response to specific areas and types of intervention. Firm classification and labelling of type of learning disability could then be linked to concessions.

3.1.2 Development of an individual programme

As initial assessment indicated that Child H had difficulties affecting a number of functional areas, his individual programme was conceptualised as multivariate, requiring a number of interventions. These are summarised in **Figure 4** below.

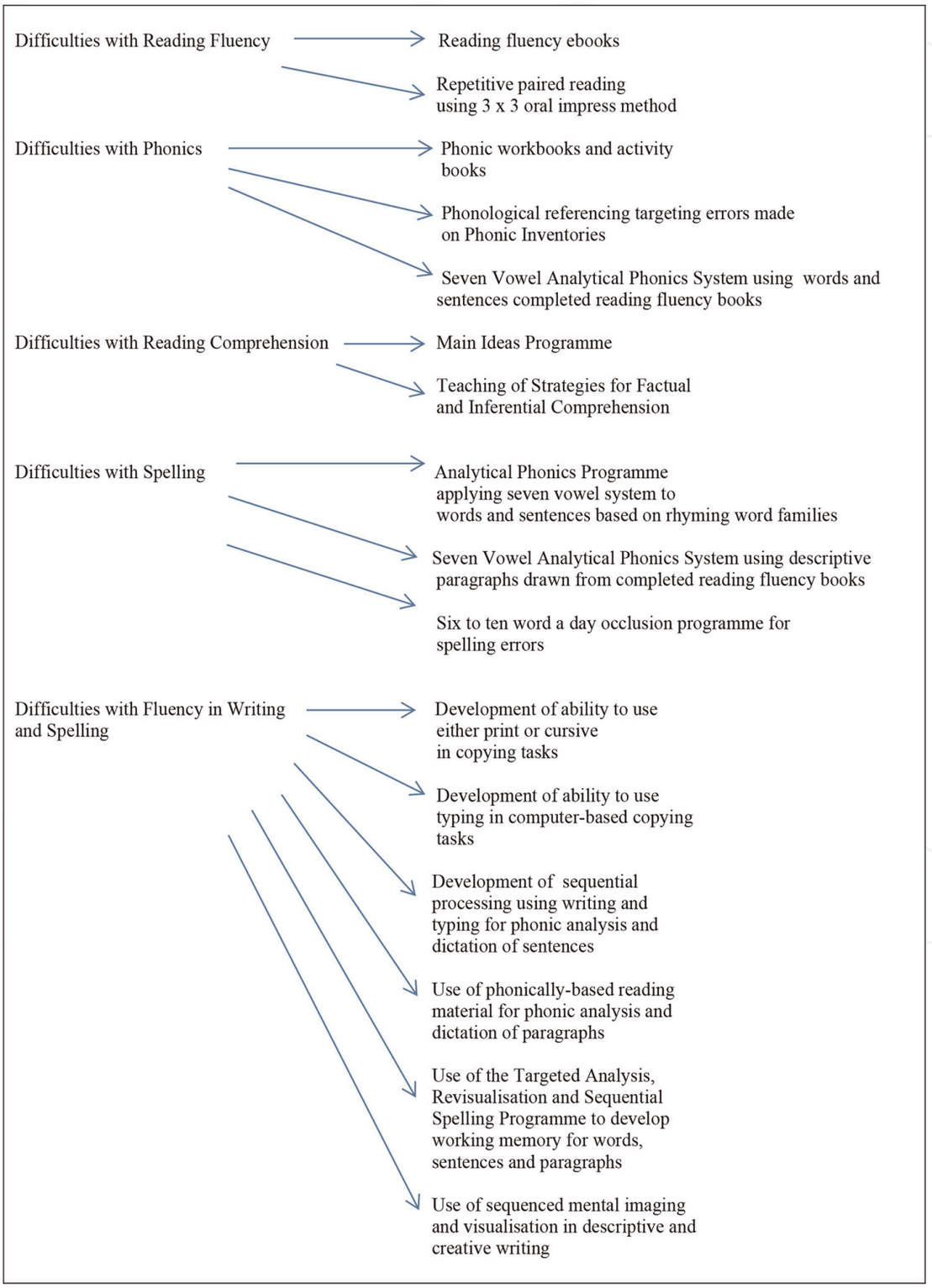

Figure 4.
Child H's individual programme.

3.1.3 Child H's individual programme here

Child H's programme was thus conceptualised as linked to a number of areas of need. The reading side of the programme would be based on interventions aimed at establishing basic phonological and phonic skills, as well as skills in both synthetic, and analytical phonics. In addition, there would be interventions designed to improve Child H's skills in word reading as well as to establish his fluency in sequential reading as the basis for improving reading comprehension. These areas would then form the basis for learning support enabling Child H to improve in the types of language and reading comprehension tasks he was being given in the classroom in Grade 4, as well as to cope with the reading and comprehension requirements of word and story sums at Grade 3 level.

In addition to the reading side of the programme, there would be interventions aimed at establishing basic skills in spelling and writing, which were also influencing Child H's ability to achieve in classroom-based tasks, as well as to keep up with the amount of work and rate of work required. These areas of the programme would be commenced by teaching Child H how to use phonological referencing to analyse the structure of the words he was being asked to learn for his spelling tests at school. This would be done by focusing on the consonant blends and vowel digraphs in these words using a seven vowel analytical system, with the aim of making the vowel system used in English orthography transparent.

Use of the Seven Vowel Phonic Analysis System would initially be introduced through work with graded phonically based material. In order to link the writing and spelling side of the intervention with the work being done in the reading side of Child H's programme, this would be done using graded written material drawn from the reading fluency books Child H had completed. This would work from Child H's spatial strengths, using methods which combined phonic analysis with word, sentence and paragraph revisualisation to develop sequential working memory for words. This would then form the basis for work with a variety of written material directed at establishing fluency in sequential writing and spelling.

The different interventions would be implemented in therapy conducted in hour long sessions conducted once per week, with carry-over through reinforcement by Child H's parents at home using electronic materials drawn from the practice's database (Note 11). There would also be a family-based counselling intervention to enable the different areas of the programme to be implemented side by side with as well as linked to Child H's school work. Work ethic and motivation would be maintained through a reward system based on hundred squares and points (Note 12).

3.1.4 Child H's initial programme: focus on reading fluency side by side with the development of phonic skills

Owing to the evidence that Child H's reading, writing and spelling problems were linked to phonological and phonic difficulties, the methods and materials used in Child H's initial programme targeted reading, writing and spelling fluency linked to interventions focusing on the development of phonic skills. The methods and materials used in the reading fluency side of Child H's programme are described in more detail in Potter [5], while the methods and materials introduced at the initial stage of Child H's writing and spelling fluency programme are described in Potter [6] as well as in Potter [8, 9].

The interventions for the development of phonic skills involved use of phonogram and rime cards to target Child H's errors on the phonic inventories, to support work done using phonological referencing [105, 106]. This focused on teaching Child H how to code from the letters used in rhyming word families back to the movements of the mouth accompanying the sounds made when reading the words, and then how to reverse code from the sequence of sounds made in the spoken word back to the written words.

Focus was initially placed on working with families of rhyming words based on similar phonological and phonemic elements. The sequence of the materials used followed the phonologically and phonically based stages in spelling described by Moats [107, 108], as well as the phonically based stages in teaching spelling in South African primary schools, which are based on use of word families. Phonic associations based on short and long vowel sounds were then reinforced by being introduced side by side with reading fluency activities using our foundation level and then our basic level readers, with the aim of developing the variety of phonic associations as well as the span of working memory necessary to read, write and spell words in sequence [105].

3.1.5 Use of phonological referencing and revisualisation in developing writing and spelling fluency

The materials used in Child H's phonological referencing programme were designed to target the specific phonic errors as well as the types of phonic errors he had made on the Phonic Inventories, whilst at the same time developing the working memory skills necessary to write words individually and in sequence. These were thus written and then taught with these two aims in mind.

These were introduced working from Child H's spatial strengths. One reason for this was that his cognitive test profile indicated that he was a spatially competent child. Another was that pragmatic testing indicated that he had the ability to use eidetic imagery in recalling letter strings and written words (Note 13). These cognitive strengths indicated that phonic associations could be taught using phonological referencing in conjunction with revisualisation. These methods implied building the areas of phonic weakness through methods enabling Child H to use his good visualisation and visual memory abilities in recalling words.

For this reason, focus was placed on working with families of between five and seven words, each of which was based on use of a similar consonant blend of cluster. As the IQ profile indicated that Child H had coding difficulties, the aim was to use Child H's visualisation and visual memory integrities to develop the phonological and phonic working memory integrities necessary to write individual words accurately, as well as the ability to write words accurately in sequence (Note 14).

In teaching the tch ending in short vowel words, for example, the following words were written in Child H's writing book.

- ditch.
- patch.
- fetch.

- botch.
- hutch.
- stretch.

The letters making the vowel sound in each of the words in the /tch/ family were then identified and underlined in colour. The phonological referencing process then involved teaching Child H how to code from the sequence of written letters in each word back to the mouth movements accompanying the sounds made when the word was spoken orally, and then how to recode from the sounds back to the sequence of letters in the word.

These associations were taught through activities in which the hand was placed under the chin, as well as through use of a mirror tile to enable Child H to match the way his mouth opened in making each vowel sound and the way his mouth closed in making each consonant sound. This was done through an activity-based process, in which Child H was asked to:

a. Point to the written word on the page and say it.

b. Look at the consonant letters at the beginning of the written word. Say the sound of these letters out loud.

c. Look at the vowel letter in the middle of the written word. Say the sound of this letter out loud.

d. Look at the consonant letters at the end of the written word. Say the sound of these letters out loud.

e. The ch phonic rule at the beginning of words and the tch phonic rule at the end of short vowel words was then taught by focusing on how the beginning sound, the middle sound and the ending sound work together to make each word, and how the tch phonic rule applied in each word.

This sequence of activities was first used to teach Child H how to code from the component sounds and letters in each word in the tch family, by linking when the word was spoken out loud with the letters used when the word was written down, and to recode from the sequence of sounds back to the written sequence of letters. Each of the words in the tch family was then contextualised in language by being used in sequence in a short sentence. The sentence was then written down by Child H, and the vowel or vowels in each word in the sentence then underlined in colour. Once this had been done, each word in the sentence was revisualised in sequence, and the sentence was then written by Child H from memory (Note 15).

The aim was thus to teach Child H how to identify the letters making particular sounds as well as combinations of letters making particular sounds in written words, and then to recode from particular sounds back to particular letters and sequences of letters in these words. This type of instruction was introduced side by side with work targeting other areas of difficulty identified in the initial assessment, as described in the following section.

3.1.6 Development of formats to support side by side implementation of treatment in a number of areas

The materials used in Child H's phonological referencing programme focused initially on specific errors made on the phonic inventories. This was introduced side by side with reading fluency work, as well as work in language, reading comprehension and maths.

As the aim was to provide graded materials in each of the areas in which Child H needed developmental work, his initial programme was implemented using a format system (Note 16), based on graded activities linked to electronic materials in the practice's database (**Table 4**).

3.1.7 Child H—Learning cycle four implemented 15th October 2016 here

Child H's initial programme was thus conceptualised as multivariate, and based on sequences of activities which had the common aim of developing fluency in reading, writing and spelling. Reading comprehension and proficiency in both processing and use of written language were conceptualised as linked to fluency in these areas, as well as to the development of working memory for individual words and sequence of words. Graded materials were then used to support work in each of these areas.

4. Linking the development of phonic associations, visual memory and sequential working memory skills

The aim of Child H's programme was to focus on needs identified in the assessment process, using strategies and methods linked to his strengths in cognitive processing and working memory. As the evidence indicated that he had underlying phonological and phonic difficulties, phonological referencing would be used to teach Child H how to code from the component sounds and letters in written words, by linking specific letters and sequences of letters with the sounds made when the words were spoken out loud with the letters used when the words were written down.

Focus would also be placed on teaching Child H how to recode from the sequence of sounds back to the written sequences of letters in words. This would be done both to teach Child H specific phonic associations between sounds and letters, as well as to attempt to address the difficulties with coding identified during the initial assessment process.

Once Child H had established the use of phonological referencing as a method for analysing the letters used to represent vowel sounds in rhyming words presented in families, colour coding of vowel letters and use of visualisation would be used to enable Child H to remember the sequences of letters used to represent the sequences of sounds in individual words, and the sequences of letters used to represent the sequences of sounds made in sequences of words in sentences. The aim was to link reading, writing and spelling through activities which used Child H's strengths in visualisation to teach the phonic associations he had difficulty in learning and remembering.

This was done using the following method:

- Child H was taught how to use phonological referencing to identify the letters used to represent the vowel. Sound in words with one syllable, the vowel sounds in words with more than one syllable and the vowel sounds in sequences of words.

	First activity	Second activity	Third activity
Day One	Repetitive Paired Reading Using 3 x 3 Oral Impress Method	Use Level One and Two Phonogram and Rime Cards to build word families based on errors from phonic inventory The tch word family ditch patch fetch botch hutch stretch Write the words in the family in your writing book. Phonologically reference and then underline the vowel in each word in colour using coloured pencils. Draw a picture next to each word to show its meaning.	Now write the following sentences based on each word: The witch has a black hat. Can the string stretch? That man will botch the job. She has a red patch on the back of her dress. My dog will run and fetch this stick. Underline the vowels in each word in each sentence in colour. Revisualise words in each sentence in sequence. Learn the words in each sentence in order. Test each sentence by dictation.
Day Two	Paired reading 3 x 3 Oral Impress Method	Test-based Language Programme: Level One Test 4 Creative writing	Maths problem-solving Level One Test 3 Working with Story Sums
Day Three	Test-based Language Programme: Level One Test 4 Written language exercises	Underline vowels in sentences in written language work on Level One Test 4 in colour. Learn these sentences using revisualisation. Test sentences through dictation.	Test-based Maths System Level Three Test 4 2 Times Table: Numerical Reasoning 5 Times Table: Numerical Reasoning 10 Times Table: Numerical Reasoning
Day Four	Reading comprehension activity Reading comprehension Comprehension level two. Snow White	Maths extension activity: level-2-multiplication-table-2-5-10-missing-factor-a level-2-multiplication-table-2-5-10-missing-factor-b Maths reinforcement activity: level-2-multiplication-table-5-missing-factor-b level-2-multiplication-table-10-missing-factor-b	Self-structured language development work using audible book "Harry Potter and the Philosopher's Stone"

Notes for Child H's parents:
Note 1: As your child has reading fluency difficulties, it will greatly assist if you can undertake repetitive paired reading working with him. Use the method outlined in your parent implementer's manual for this, working for a 20 minute session four times a week.
Note 2: As discussed, the initial assessment also indicates that your child also has a number of difficulties with phonics. These affect his use of consonant blends as the beginning and end of words.
These affect the following beginning blends.
sk/ cl/ qu/.
and the following ending blends.
/ft. /st /ff /nk /sh /tch /dge /ngth.
He also has some difficulties with identifying the correct letter to represent the /a/ and /e/ and /i/ short vowel sounds. He still reverses the /b/ and /d/ in certain words.
These difficulties indicate underlying phonological problems which affect writing and spelling. These need to be worked within his writing book using our Level One phonogram and rime cards to build word families targeting the errors highlighted above. The words in the word families then need to be used in sentences, learned and then tested.
Note 3: I have provided you with electronic materials to support the activities in the format by email. These can be used for additional sessions conducted at home to reinforce and support your child's programme.

Table 4.
Child H – learning cycle four implemented 15th October 2016.

- The letters representing the vowel sounds in each word in the sentence were then underlined in colour.
- Once this had been done, each word in the sentence was revisualised in sequence.
- The sentence was then written by Child H from memory.

Writing and spelling fluency was thus conceptualised as linked to Child H's ability to retrieve the sequences of letters used to represent sounds in words accurately and quickly. Accuracy and rate of writing would then be developed through a hierarchy of methods which aimed to link the development of phonic associations, visual memory and working memory for individual words and sequences of words, as outlined in **Figure 5** below.

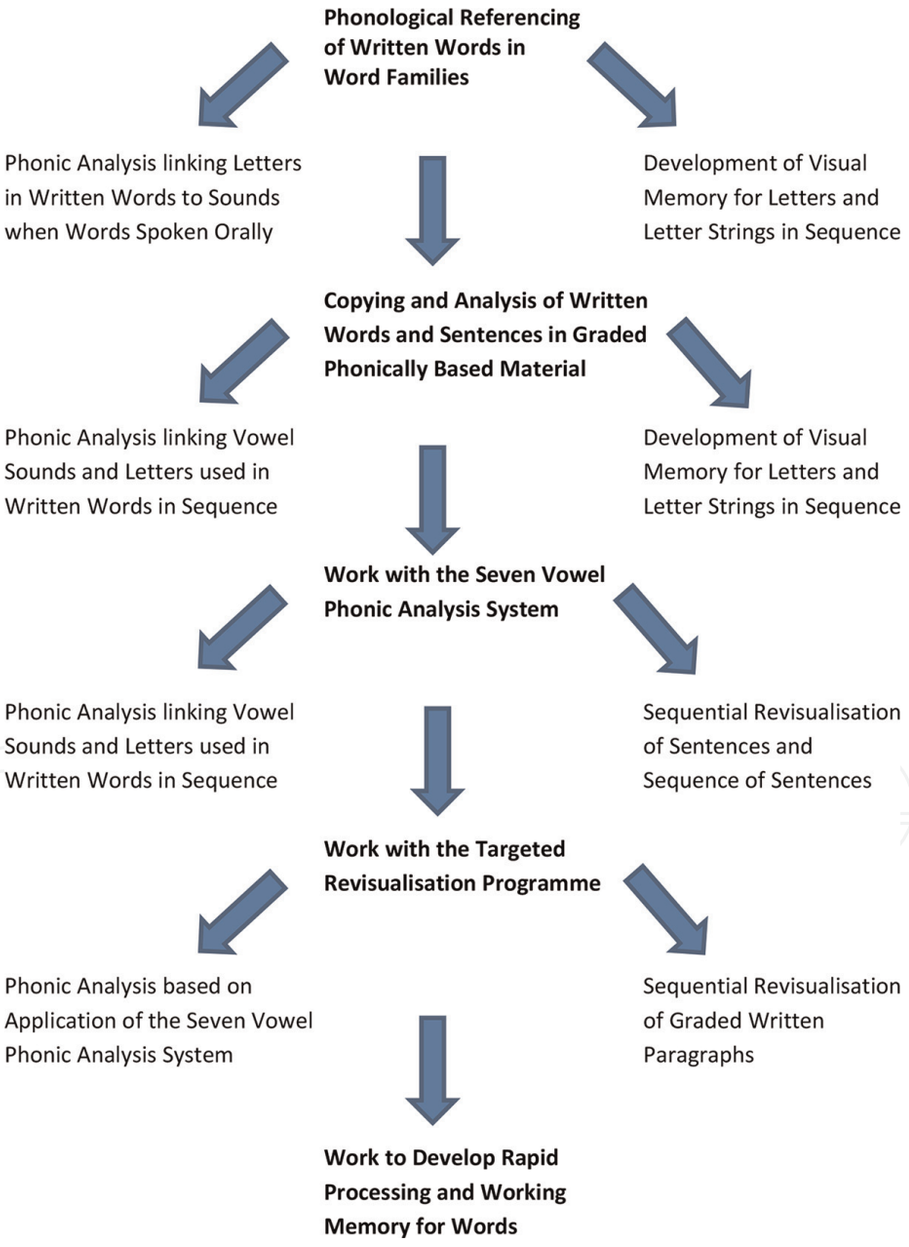

Figure 5.
Methods linking phonic analysis, visual memory for strings of letters and words and sequential working memory for written words, phrases, sentences and paragraphs.

4.1 Methods linking phonic analysis, visual memory for strings of letters and words and sequential working memory for written words, phrases, sentences and paragraphs here

4.1.1 Methods to develop rapid processing and working memory for words

The aim at each level in Child H's writing and spelling fluency programme was to link the development of phonic analysis, working memory for individual words and sequential working memory skills. This would be done using methods which combined phonological referencing and phonic analysis with use of Child H's strengths in visualisation as well as in visual memory.

Phonological referencing and phonic analysis would be used as a means of coding the sequences of letters used in representing sounds in individual words and sequences of words. Visualisation and revisualisation would then be used to develop working memory for individual words and sequences of words.

This was done at each of the stages in Child H's writing and spelling fluency programme, as described in the sections following.

4.1.2 Stage one in child H's writing and spelling fluency programme: using phonological referencing to code and recode phonic associations

Stage One of Child H's writing and spelling fluency programme involved a process in which:

- Child H was taught to map the associations between the sequences of letters.
- used in words and the sequences of sounds used when words are spoken orally.
- through phonological referencing, as well as through use of phonogram and rime cards.
- He was taught that each written word is logical and can be analysed on the principle that "what we say is what we write".
- He was asked to read words, and then cover them and write them from memory.
- He was then shown how to use revisualisation to remember the sequences of letters used in individual words and the sequences of words in used in sentences.

As Child H had phonological difficulties affecting the development of his phonic skills, the aim was to develop his phonological and phonic abilities, while at the same time developing the sequential working memory integrities necessary to store individual words as well sequences of words in working memory. This was done by working with rhyming words in the context of single sentences, and then with sequences of sentences.

At this stage Child H's working memory for individual words was tested orally and in writing. His sequential working memory for words was tested through dictation of the words he had revisualised in sequence. Any words on which spelling errors were made were then relearned using occlusion (Note 17).

4.1.3 Stage two in child H's writing and spelling fluency programme: increasing the transparency of written English through use of a seven vowel phonic analysis system

Child H's phonic inventories indicated that he made many errors on words based on long vowel sounds. He also had difficulties with remembering the sequences of letters used to represent long vowel sound in words. These difficulties affected his ability to write and spell fluently in the classroom.

Child H had been taught at school through use of word families and weekly spelling tests, but had difficulties in retaining and remembering the words he had been taught. For this reason in Stage Two of Child H's writing and spelling fluency programme he was taught using a Seven Vowel Phonic Analysis System designed to increase the transparency of written English.

The logic of teaching seven as opposed to five vowels was based on the consistencies in the way the English language is written down on paper. Phonological referencing was used to teach Child H that the two main consistencies are that:

- the long vowel sounds are usually written using combinations of the five letters a, e, i, o and u. These are usually written in pairs (called vowel digraphs).

- the long vowel sounds can be mapped from the combinations of letters used to write long vowel sound in words back to the sounds made when the words at spoken orally. These can be identified from the sounds made when the mouth opens to make the vowel sounds.

Child H was then shown that there are also other consistencies in the way the English language is written down on paper, as follows:

- the letter /y/ can act as a vowel at the end of words (as in "my", "try" and "fly").

- the letter /y/ can act as a vowel when written in combination with another vowel letter at the end of words (as in "day" or "toy", or "guy").

- in addition, the letter /w/ can also act as a vowel when written in combination with another vowel letter at the end of words (as in "cow" or "law" or "few" or "grew").

This was the logic applied in the Seven Vowel Phonic Analysis System, which was taught using Phonological Referencing based on two simple rules:

a. The letters a, e, i, o and u act as vowels in all positions in words.

b. The letters y and w can act as vowels at the end of words and also at the end of syllables in words.

5. Applying the seven vowel phonic analysis system in stage two of child H's writing and spelling programme

In Stage One of Child H's writing and spelling fluency programme, he had been taught that the vowel sounds are made when the mouth opens, and consonant sounds

are made when the mouth closes. This had been done working with a mirror tile so that he could listen to and speak the sounds in words while looking at how his mouth moved when making the consonant and the vowel sounds. He was also shown that he could phonically analyse words by putting his or her hand under his chin to feel how his mouth moved when saying words while as the same time using the mirror to look at how his mouth moved when saying words.

At Stage Two of his writing and spelling fluency programme, written words and printed words drawn from the content of our reading fluency books were used to show Child H that each word is based on at least one vowel sound, and that what we say is what we write. This consistency was taught by analysing both single words and sequences of words in sentences. This was done by using printed material drawn from reading fluency books from our series, which Child H had read and used both for repetitive paired reading and had also used as workbooks for drawing and illustration.

The method used was as follows:

- Child H was asked to copy a short paragraph from a completed reading fluency book into his writing book.

- Phonic analysis of each word in each sentence was then undertaken using coloured pencil crayons to map from the spoken words map to the letters used in the written words.

- The letters used to represent the vowels in each word he had written in his writing book were then underlined in colour.

Phonological referencing was thus used in conjunction with colour coding to teach Child H how to phonically analyse individual words and sequences of words in sentences, and then in paragraphs drawn from the phonically based written material in our reading fluency books (Note on the fact that these are both phonically based and graded). Phonological referencing provided a simple activity-based process for identifying the letters which made the vowel sounds in each written word.

This then enabled the logic of the Seven Vowel Phonic Analysis System to be used to code from the written words back to the spoken words, and then to recode from the spoken words back to the written words in sequence. After being phonically analysed, these colour coded words were then revisualised in sequence and written from memory.

5.1 Stage three: increasing span of sequential working memory for words

Once Child H was able to recall sentences of between five and seven words accurately, span of sequential working memory was increased by work with sentences of increasing length, as well as by work with increasing numbers of sentences in sequence. As our reading fluency materials are graded and phonically based, words, sentences and paragraphs could be drawn from these as the basis for Stage Two activities which linked reading, writing, spelling and sequential working memory work.

Span of sequential working memory could then be increased by initially revisualising single sentences and then more than one sentence at a time. This took place gradually, first focusing on developing Child H's ability to analyse, revisualise

and then write the sequences of phonically based words in a single sentence accurately, and then on increasing his span of sequential working memory by developing his ability to write more sequence of words in more than one sentence accurately.

Once it was apparent from Child H's written output that he was able to memorise and write three sentences drawn from a phonically based paragraph accurately, more complex graded paragraphs and sequences of paragraphs were then introduced. This was done in Stage Three of Child H's writing and spelling fluency programme using targeted revisualisation.

This was done using materials and methods from the Targeted Analysis, Revisualisation and Sequential Spelling Programme, which is described in the section following.

5.1.1 Stage four in child H's writing and spelling fluency programme: introducing the targeted analysis, revisualisation and sequential spelling programme

As its name implies, the Targeted Analysis, Revisualisation and Sequential Spelling Programme aims to use targeted revisualisation to develop the ability to recall the words used in individual sentences and sequences of sentences accurately. This is done working with graded paragraphs.

At Stage Four in Child H's writing and spelling fluency programme, he was placed on graded material drawn from Schonell's Graded Dictation programme. As the content of Schonell's programme was written more than 50 years ago, some of the paragraphs were clearly dated, while others expressed content which was felt to be inappropriate and possibly offensive. These paragraphs were redrafted.

For this reason, the material was checked and then revised or rewritten. The content was then supplemented by other graded material using different language registers, as well as content drawn from Child H's school books.

This was introduced using the following hierarchy of activity-based methods (**Figure 6**):

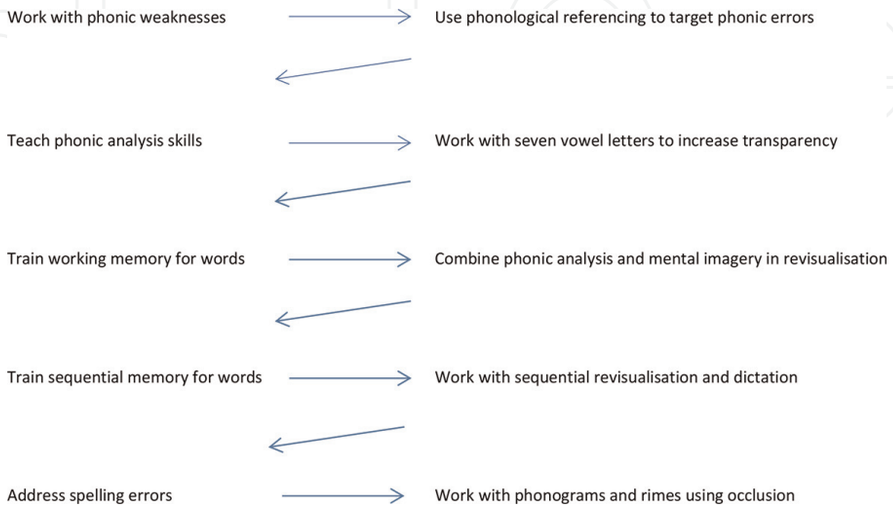

Figure 6.
Hierarchy of activity-based methods applied in the targeted analysis, revisualisation and sequential spelling Programme.

6. Hierarchy of activity-based methods applied in the targeted analysis, revisualisation and sequential spelling programme here

The aim of using this hierarchy of methods was to extend use of both Phonological Referencing and use of the Seven Vowel Phonic Analysis System in targeting a wider variety of written words in which the vowel sounds were made with more than one letter. This was done in the following way:

- Words in the paragraph which more than one letter was used to represent the vowel sound or vowel sounds were identified as target words.
- The target words were first listed by Child H in his writing book and then typed on the computer.
- The letters used to represent the vowel sounds were then phonologically referenced and colour coded.

After this, the written and typed words were syllabified, so that words based on more than one syllable could be divided spatially to reduce the number of letters into manageable chunks for purposes of revisualisation. The words were then revisualised individually and in sequence, using methods in which both phonic analysis and use of visualisation were combined in the revisualisation process.

6.1 Applying the seven vowel phonic analysis system to written language based on different language registers

In Stage Four of Child H's writing and spelling fluency programme, he was thus taught how to apply the targeted revisualisation process using graded paragraphs, with the aim of developing working memory for individual words as well as words in sequence. Span of working memory was then increased by using graded written paragraphs based on different language registers used in different contexts. This was done as follows:

a. Child H was first taught how to use both phonological referencing and the Seven Vowel Phonic Analysis System to colour code the seven letters used to represent the vowel sounds in written words drawn from paragraphs of increasing length and phonic complexity.

b. As in Stage Three of his writing and spelling fluency programme, this involved focusing on the use of the letters a, e, i, o and u to represent short and long vowel sounds in all positions in words and the use of the letters y and w to represent short and long vowel sounds in positions at or near the end of words.

c. Phonic analysis and revisualisation were then combined to develop working memory for words in which more than one letter was used to represent the vowel sounds. After being identified, listed in writing, typed and colour coded, the target words were then syllabified and revisualised in sequence.

d. The targeted revisualisation methods were then applied to develop working memory for words in sequence, working with paragraphs which increased in length and phonic complexity.

The aim of the methods used in Stage Four of Child H's writing and spelling fluency programme was thus to enable Child H to use his good visual memory and spatial competencies to address his phonological and phonic difficulties, by use of phonological referencing, phonic analysis and revisualisation in developing working memory for individual words and for words in sequence. This was done by drawing on Child H's visual and spatial strengths in teaching him how to code and then recode the sequences of letters used in writing words accurately.

The combination of phonic analysis and revisualisation methods was applied repetitively in implementing the sequence of graded paragraphs used in the programme. This was also documented in a parent implementer's manual (reference) so that the methods used in The Targeted Analysis, Revisualisation and Sequential Spelling Programme could be reinforced with work done by Child H's parents at home.

7. Use of clinical teaching in programme implementation

In implementing the activities described above, each session worked with Child H was implemented using clinical teaching on the following action research-based model (**Figure** 7). This was done to enable the focuses and sequence of instruction in the programme to be based on evidence from cognitive testing combined with pragmatic evidence indicating how Child H learned. It was also done to evidence from implementation to be used to establish how Child H learned optimally in working to address his phonological and phonic weaknesses.

7.1 Action research cycle for planning and implementation of child H's activity-based programme here

The value of using this type of action research framework in classroom work has been described by Stenhouse and his colleagues [109–113]. In working with Child H, this type of session by session progress evaluation was conducted to enable his programme to be planned and altered session by session. This was done to establish how he learned optimally, as we worked to address his phonological and phonic weaknesses.

Based on this ongoing planning and evaluation process, materials for developing reading, writing and spelling fluency in Child H's programme were sent as email

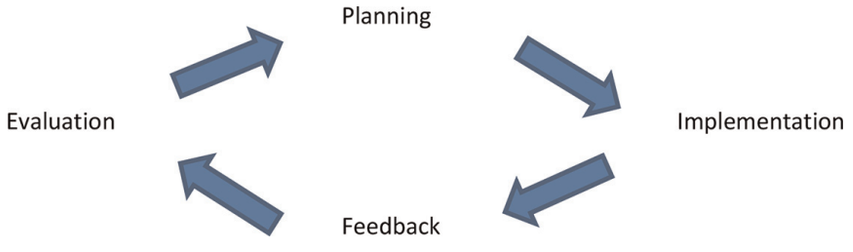

Figure 7.
Action research cycle for planning and implementation of child H's activity-based programme.

attachments on a weekly basis to Child H's parents. The methods used were also summarised in illustrated in parent implementer manuals [114–118] which could then be used to reinforce the methods used at home.

7.2 Evaluating response to intervention

Child H's progress at school was monitored through contact with his school teachers as well as regular reports on his classroom progress. These indicated that despite continuing difficulties with reading, writing and spelling, he was a well-liked member of the school community who excelled at swimming and other sports. His school reports indicated steady progress in all subjects, despite his ongoing difficulties with reading, writing and spelling.

In addition, progress evaluation was conducted through scholastic testing undertaken annually, to enable comparison of age scores, based on re-administration of the tests administered at time of Child H's initial assessment in 2016. The results are presented in the **Table 5** below.

7.3 Child H—longitudinal indicators of ongoing difficulties with one word reading, sequenced reading, one word spelling and sequential spelling here

It will be evident from the age scores in **Table 5** that Child H continued to have reading, writing and spelling fluency difficulties despite a number of different interventions conducted over a three-year period. These had involved use of a multivariate treatment approach based on implementation of phonically based reading, writing and spelling programmes, work to develop Child H's rapid naming and coding abilities, as well as work to develop working memory for words using phonological referencing techniques, as the basis for use of phonic analysis, visualisation and revisualisation methods.

Based on cumulative evidence of Child H's response to a number of different types of interventions, it was possible to motivate for additional time in tests and examinations once he reached the age of 12, as well as for a spelling concession. At the beginning of his Grade 6 year at primary school, IQ as well as achievement testing done, together with an analysis of reading difficulty based on diagnostic testing of reading comprehension, rate of reading, rapid word reading, word analysis, spelling, handwriting and working memory for words. The phonic inventories were also readministered at this point in time.

These results are reported below.

	November 2016	November 2017	November 2018
One word reading	7 yrs. 10mths	8 yrs. 3 mths	8 yrs. 10 mths
Sentence reading	8 yrs. 11 mths	8 yrs. 11 mths	9 yrs. 10 mths
One word spelling	7 yrs. 6 mths	8 yrs. 5 mths	8 yrs. 10 mths
Spelling in sequence	6 yrs. 10 mths	7 yrs. 0 mths	7 yrs. 6 mths
Chronological age	9 yrs. 6 mths	10 yrs. 6 mths	11 yrs. 6 mths

Table 5.
Child H: Longitudinal indicators of ongoing difficulties with one word Reading, sequenced Reading, one word spelling and sequential spelling.

7.3.1 Child H's profile on the WISC IV (UK)

Child H's performance on the different subtests of the WISC IV (UK) [119] is summarised in **Table 6** below, which presents the profile of standard scores obtained in the verbal comprehension, perceptual reasoning, working memory and processing speed areas of the test.

7.3.2 Child H—profile of standard scores on the WISC IV (UK) (March 2019) here

As in the IQ administered 3 years before, Child H's performance in all areas of the test was in the normal range. There was still evidence of some scatter in level of performance across different areas of the test, but within the different areas of the test there was far more homogeneous performance.

The verbal comprehension profile now indicated that Child H had well developed verbal reasoning ability, and average vocabulary, comprehension, general knowledge and verbal classification abilities relative to age level. The perceptual reasoning side of the test indicated well-developed perceptual and spatial abilities relative to age level. Child H's previous weakness in non-verbal reasoning was no longer evident, while the

Verbal Comprehension			**Perceptual Reasoning**		
Subtest	What subtest measures	Standard score	Subtest	What subtest measures	Standard score
Similarities	Verbal abstract reasoning and word finding ability.	12	Block Design	Abstract non-verbal reasoning, spatial perception and organisation.	12
Vocabulary	Ability to explain the meaning of words.	12	Picture Concepts	Abstract ability to analyse and classify pictorial information.	13
Comprehension	Social understanding and judgement.	12	Matrix Reasoning	Non-verbal abstract reasoning and concept formation.	14
	Working Memory			Processing Speed	
Subtest	What subtest measures	Standard Score	Subtest	What subtest measures	Standard score
Digit Span	Short-term auditory memory.	11	Coding	Ability to work at speed in applying a simple code accurately and in sequence.	7
Letter-Number Sequencing	Ability to manipulate letters and numbers sequentially by holding them in short term and working memory.	10	Symbol Search	Ability to work at speed in establishing whether particular symbols are present or absent.	9

Note that in the above table, a standard score is a scaled score relative to a normal curve, where the average score would be a score of 10. Scores higher than 12 indicate above average performance relative to age level, indicating potential areas of cognitive strength. Scores lower than 8 indicate below average performance relative to age level, indicating potential areas of cognitive weakness. This type of profile interpretation needs to be conducted cautiously and substantiated against other information, as any scaled score is subject to measurement error.

Table 6.
Child H – profile of standard scores on the WISC IV (UK) (march 2019).

scores in the working memory side indicated good short-term auditory memory as well as good sequential memory for letters and numbers.

Relative to Child H's standard scores in other areas of the test, there were still difficulties in processing speed. There was a particular weakness in coding, but the standard score indicated improvement relative to Child H's performance on this subtest in the IQ administered 3 years previously.

Overall there was thus evidence of some scatter in the test scores, but a far less scattered profile compared to 3 years previously. This will be evident from the graph presented below, which groups the standard scores on the IQ by cognitive area (**Figure 8**).

7.3.3 Child H—profile of standard scores on WISC IV (UK) (march 2019) grouped by cognitive area here

The indications from the profile were that Child H now had well-developed cognitive processing abilities in both verbal and non-verbal areas as well as well-developed auditory and auditory sequential memory skills. There were still weaknesses affecting processing speed. Coding was still a particular area of difficulty indicating continuing needs for intervention in developing sequential working memory for words. The indications were also that Child H's strengths in all other areas of the test could now be used as the basis for interventions to improve his functioning in writing and spelling.

This was done by using the high areas in the IQ as indicators of strengths in Child H's cognitive style at this point in time, and the low areas as indicators of weakness. These cognitive processing indicators were then supplemented with clinical evidence of the working memory strategies which Child H was using in remembering individual words and words in sequence (Note 18). The conclusion was that the tests of basic reading, writing and spelling skills conducted longitudinally over the past 3 years provided evidence of continuing difficulties with reading fluency, as well as with writing and spelling fluency. The age scores also fell well below what would be expected in terms of age level as well as Child H's overall level of cognitive performance, indicating that diagnosis of a reading disorder under DSM-IV code 315.00 was still applicable (Note 19), as well as a disorder of written expression in terms of the diagnostic criteria for DSM-IV code 315.2 (Note 20).

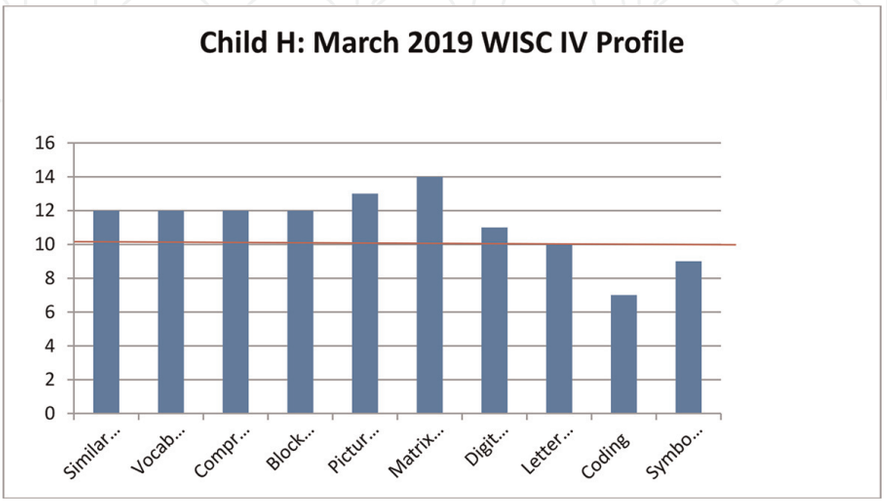

Figure 8.
Child H — profile of standard scores on WISC IV (UK) (march 2019) grouped by cognitive area.

The evidence also indicated a long-term difficulty in these areas, suggesting an ongoing learning problem likely to affect performance in school. Coding was still a particular weakness. Low scores on coding are often associated with difficulties in reading [120, 121], and for this reason Child H's continuing weakness in this area of the test indicated the need for continuing interventions to develop his coding and recoding abilities [122–126]. This required continuing focus on developing his visual memory for words, as indicated in the following section.

7.3.4 Child H's profile on the Durrell

As evidence from longitudinal testing of Child H's skills in one word reading, sequenced reading, one word spelling and sequential spelling was already available (refer **Table 5** above), the Durrell Analysis of Reading Difficulty was administered as part of his response to intervention assessment. The Durrell has a number of subtests of rate of reading as well as subtests tapping the ability to use phonic skills and visual memory, on which Child H scored as follows.

Results of reading, writing and spelling tests conducted on 2019-2109-27:
Durrell Oral Reading (rate) 8 yrs. 8 mths
Durrell Oral Reading (comprehension) 9 yrs. 6 mths
Durrell Silent Reading (rate) 8 yrs. 8 mths
Durrell Silent Reading (comprehension) 9 yrs. 9 mths
Durrell Listening Comprehension 10 yrs. 2 mths
Durrell Flash Words 11 yrs. 5 mths
Durrell Word Analysis 11 yrs. 8 mths
Durrell Test of Spelling 8 yrs. 0 mths
Durrell Test of Handwriting 11 yrs. 0 mths
Durrell Test of Visual Memory 9 yrs. 8 mths
Durrell Test of Phonic Analysis 12 yrs. 3 mths

The scatter on the various subtests will be evident from the profile of test scores presented below, which shows the discrepancy between Child H's age (line in red) and his age scores on the different subtests administered (**Figure 9**):

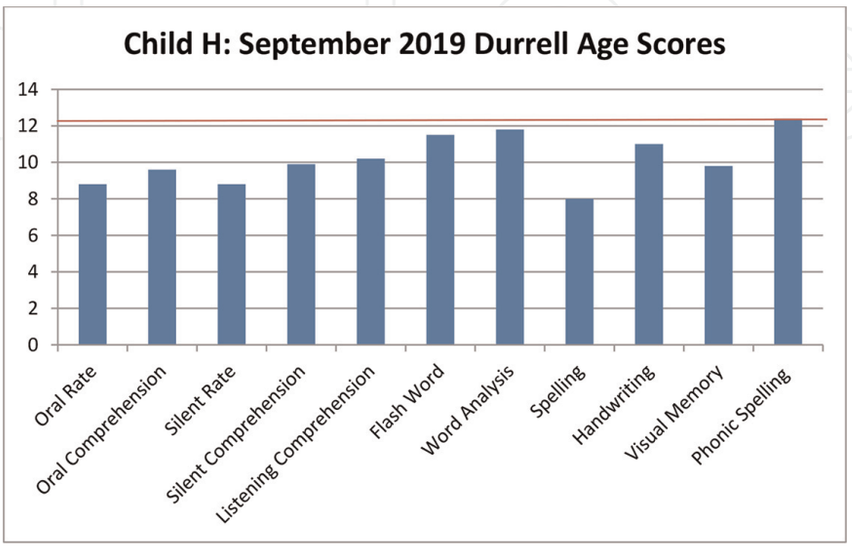

Figure 9.
Child H — profile Durrell age scores (September 2019).

7.3.5 Child H—profile of 2019 Durrell age scores (September 2019) here

Child H's continuing difficulty with rate of work in school-related activities was indicated both by his parents and his self-reports. The Durrell profile indicated that this was linked to difficulties with rate of reading and comprehension of contextual paragraphs. When compared to the scores from previously administered tests of reading, writing and spelling, the Durrell profile indicated improvement in the reading of individual words as well as in rapid recognition of letters and words, while the working memory subtests indicated progress in phonic spelling but continuing difficulties with visual memory for words. This would still need to be treated side by side with the reading and spelling sides of Child H's programme.

7.3.6 Child H's profile on the phonic inventories

As Child H was at this stage in Grade 6 at school, all three levels of the Phonic Inventories were administered (Note 21). The profile Child H's profile indicated high error scores on:

- Ending consonant blends.
- Medial vowels in words based on long vowel sounds.
- Polysyllabic and compound words based on short vowel sounds.

On the basis of previous research with the instrument which had indicated that errors on both ending consonant blends and medial vowel errors are indicators of learning disability both in primary school age children [99, 100] as well as high school children [101]. Child H's profile of errors on the instrument was used as corroborating evidence of the presence of a learning disability [90, 127, 128], while also providing evidence of specific areas of learning need. In addition, the profile was analysed to identify specific phonic errors and error types which could be targeted for instruction [129–131].

Compared to the previous profile of phonic errors made when Child H was in Grade 3 at school, his Grade 6 profile of errors on the phonic inventories provided evidence that substantial progress had been made in terms of his underlying phonological and phonic difficulties, as well as evidence that further work was necessary. This needed to target the specific errors made by Child H on ending consonant blends, continuing work on the use of letters used in combination to represent long vowel sounds, and work on base words combined with prefixes, suffixes and other morphological endings.

8. Firm classification of child H's learning difficulties based on response to intervention

Based on the evidence of Child H's response to a number of different treatment interventions which indicated continuing difficulties with reading, writing and spelling as well as continuing difficulties with phonics, Child H was classified for both medical aid and concession purposes as having dyslexia (Note 22). The classification

provided was based on the use of ICD10 indicators linked to the presence of a number of continuing areas of difficulty affecting a number of areas of scholastic functioning.

Motivation was then made for reading, spelling and rate of work concessions based on the dyslexic classification. In addition, the evidence from Child H's Grade 6 response to intervention assessment was linked to the need for ongoing intervention in a number of areas and the continuing implementation of a multivariate treatment programme.

Labelling Child H as dyslexic was at this stage based on both quantitative and qualitative data using multimethod, data and time triangulation [73, 132]. The diagnosis was firm, and based on incremental data from cross-sectional concurrent assessment as well as longitudinal evidence of Child H's response to specific types of intervention. This then formed the basis for concessions, as well as planning of the interventions necessary to support Child H's transition from primary school to high school.

9. Planning for the transition from primary to high school

After using the dyslexic diagnosis to motivate for concessions, the next step in planning for Child H's transition to high school was to work with the evidence from his Grade 6 assessment in replanning his programme. This was done using the indicators of cognitive strengths and weakness from the recent IQ, combined with scholastic test and working memory indicators.

Both the Phonic Inventories and the Durrell indicated that Child H had made substantial progress in applying phonic rules in the reading and spelling of individual words, while the working memory indicators in the Durrell indicated progress in phonic spelling but continuing difficulties with the development of higher level phonic associations, visual memory for words and rate or work. There were also continuing difficulties with reading fluency as well as writing and spelling fluency, indicating needs for interventions involving:

- activities to improve rapid naming of letters, words and numbers.
- activities to increase accuracy and speed of reading.
- activities to improve coding and recoding abilities.
- activities directed at improving visual memory for words.

Based on this, Child H's programme was replanned with continuing focus on the development of reading fluency and comprehension, accurate spelling of both individual words and sequences of words and activities designed to increase ability to process written work rapidly. This included use of a stop watch to work on reading, writing and spelling activities against pressure of time, as well as rapid reading and working memory activities based on use of an electronic tachistocope.

10. Increased emphasis on work on visual memory and rapid naming

Work was thus continued on programmes previously used for phonological referencing, phonic analysis and visual memory development, as well as work on

rapid naming using registers of words that were familiar to Child H. This was linked to activities to develop accurate and rapid memory for individual words and words in sequence. Tachistoscopic work was also introduced [118], working repetitively with words of increasing length drawn from an electronic dictionary. In addition, Child H was asked to create custom lists of words in which more than one letter was used to represent the vowel sounds. The target words were drawn from graded paragraphs previously used for targeted revisualisation, as well as from Child H's school books.

In introducing activities using the electronic tachistocope, length of words, time exposure of the presentation of each word and the time between the exposure of each word were conceptualised as treatment variables for rapid naming, as in the model presented in **Figure 10** below.

10.1 Methods for treating rapid naming difficulties here

Other variables could also be included in the model by varying the ways in which words were presented, read, revisualised and written down, by varying the exposure as well as the length of words presented electronically. The aim was to link the tachistocopic methods used for developing Child H's ability to rapidly recognise and remember words to the methods being used in other areas of the programme for training fluency in reading, writing and spelling. This was done through use of thematically based vocabulary presented tachistoscopically in activities designed to link rapid naming of words [133, 134] with written activities aimed at developing usage of the words in context. This was combined with use of computer-based speech to print technologies in which words used in context orally could be linked to words printed and read.

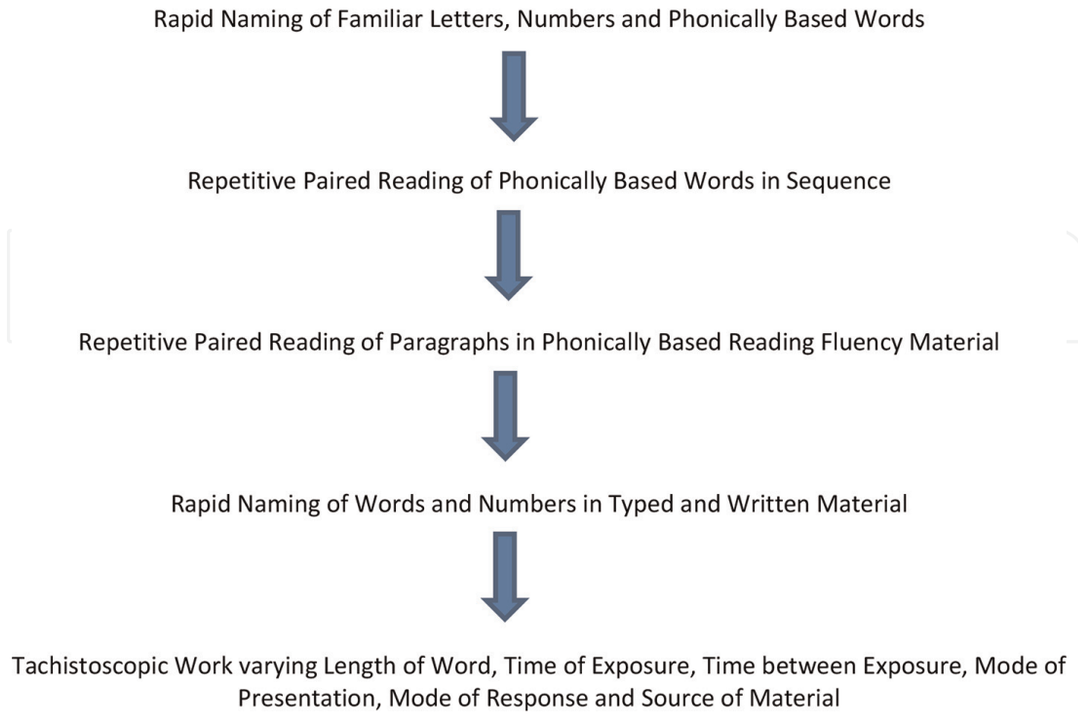

Figure 10.
Methods for treating rapid naming difficulties.

10.2 Progress evaluation (September 2020)

Over his Grade 6 year at primary school, Child H continued to work on the different areas of his programme diligently with the help of his parents. He found both the revisualisation-based activities and the tachistoscopic work particularly helpful, and reported that these were assisting his reading, writing and spelling as well as his rate of work in the classroom (Note 23).

As the aim was to achieve a level of literacy (Note 24) before the end of primary school, the Durrell Analysis of Reading Difficulty was redone in October 2020, to see whether there had been change in Child H's levels of reading, writing and spelling prior to his final Grade 7 year.

The profile of Child H's age scores on the Durrell at this point is presented in **Figure 11** below.

10.3 Child H—profile of Durrell age scores (October 2020) here

It was evident from comparing the 2019 and 2020 Durrell profiles that there had been improvements in a number of different areas of reading as well as in visual memory for words. The improvements in visual memory were particularly marked. Child H attributed these improvements both to continued focus on activities involving use of sequential memory for words and use of the tachistoscope for rapid processing and recall of individual words (Note 25).

At this point it was evident that Child H's transition to high school was likely to be accompanied by continuing difficulties with reading, spelling and rate of work. External assessment was thus conducted to confirm the classification of Child H's learning difficulties as linked to dyslexia, for which continuing concessions at high school would be necessary.

The results of this assessment are reported in the next section.

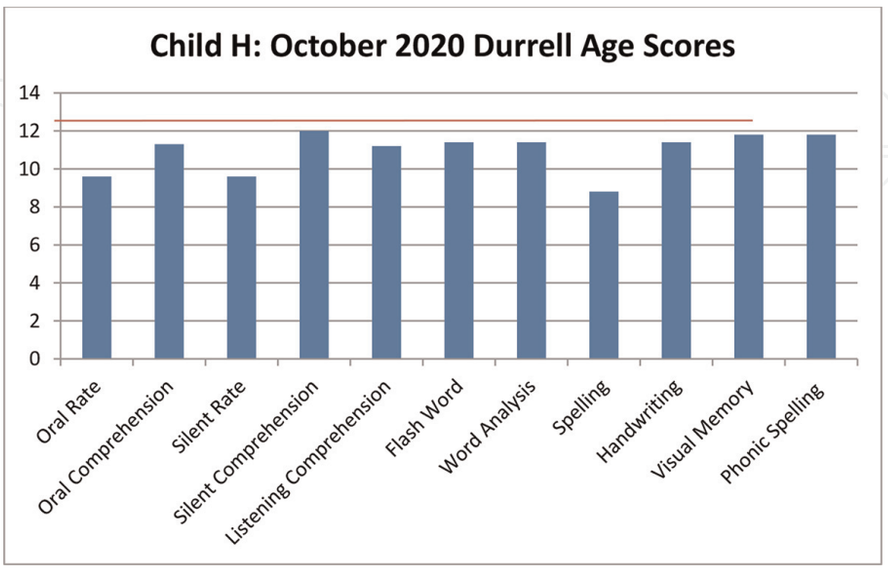

Figure 11.
Child H – profile of Durrell age scores (October 2020).

11. Application for concessions to support child H's transition to high school

In February 2021, a full psycho-educational assessment was conducted to determine Child H's levels of cognitive and scholastic functioning in his final year at primary school, so that recommendations could be made in terms of what support may be required to assist him in achieving to potential, as well as to make recommendations with regards to formal accommodations and concessions.

The assessment was done by an independent psychologist (Note 26), and was based on the following measures:

- The Wechsler Intelligence Scale for Children – WISC-V.
- Subtests from WIAT 2.
- The Test of Word Reading Efficiency (TOWRE).
- Edinburgh Reading Assessment Level 4.
- Word Chains.
- Written expression examples.
- Clinical Observations and Informal Assessment.

Child H's mother requested that previous assessment reports be utilised in order to provide all relevant background information relating to Child H's early development, medical, school and therapy history, and personal information. The results of this case study up to this point in this chapter could then be included with the application documents concessions.

12. Summary of index performance

The WISC-V is made up of various subtests that are grouped into five categories or indices, which can be used for interpretation of a child's different types of cognitive abilities. The following is a summary of Child H's performance on the indexes. Index scores lying between 85 and 115 indicate an average range of performance relative to other children of similar age, while index scores beyond this range of scores indicate above or below average performance (**Table 7**).

13. Child H—range of performance on WISC-V indices (February 2021) here

As in the IQ administered in 2016 and 2019, Child H's performance in all areas of the test was in the normal range. Comparing the test profiles, there was still evidence of some scatter in level of performance across different areas of the test, but within the different areas of the test there was far more homogeneous performance.

Index	Subtests Measure	Performance
VERBAL COMPREHENSION	Processing of verbal information	Average range
VISUAL SPATIAL REASONING	Processing and manipulation of visual and spatial information	Superior range
FLUID REASONING	Problem-solving ability	Average range
WORKING MEMORY	Short-term memory	Average range
PROCESSING SPEED	Rate and accuracy of mental processing	Low Average range
FULL SCALE	General cognitive functioning	Average range

Table 7.
Child H — range of performance on WISC-V indices (February 2021).

The verbal comprehension profile in 2021 indicated that Child H had well-developed verbal reasoning ability, and average vocabulary, comprehension, general knowledge and verbal classification abilities relative to age level. The perceptual reasoning side of the test indicated adequately developed perceptual and spatial abilities relative to age level, but the previous weakness in non-verbal reasoning was no longer evident, while the scores in the working memory side indicated good short-term auditory memory as well as good sequential memory for letters and numbers.

Relative to Child H's standard scores in other areas of the test, there were still difficulties in processing speed. There was still a particular weakness in coding, but the standard scores indicated improvement relative to Child H's performance on this subtest in the IQ administered 3 years previously.

Overall there was thus evidence of some scatter in the test scores, but a far less scattered profile compared to those from both the previously administered IQ tests. This was evident from the graph presented below, which groups the standard scores on the IQ by cognitive area (**Figure 12**).

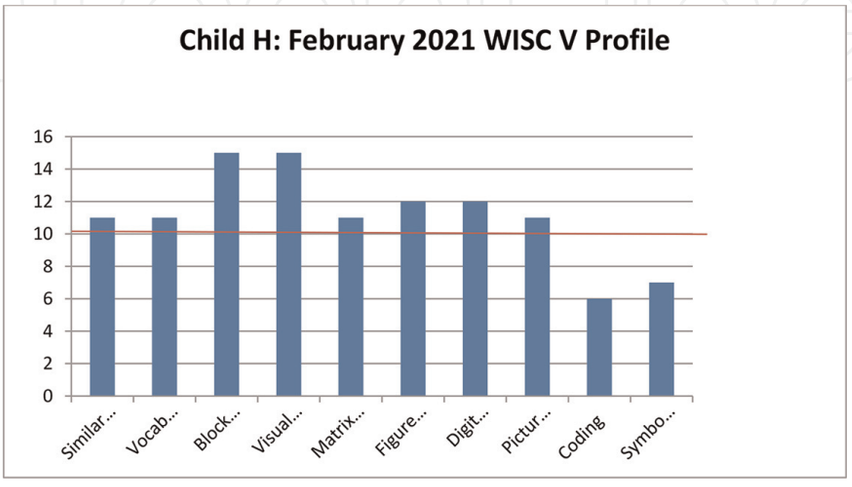

Figure 12.
Child H – profile of standard scores on WISC V (UK) (February 2021) grouped by cognitive area.

14. Child H—profile of standard scores on WISC V (UK) (February 2021) grouped by cognitive area

The profile provided evidence of spatial competence, as well as evidence of ongoing difficulties with processing speed linked to difficulties with coding. As the coding subtest has been retained unchanged in each restandardisation of the WISC (Note 27), Child H's raw coding scores were compared over time. This analysis indicated that steady gains had been made over a four-year period in raw scores, but that Child H still had continuing weakness in coding relative to other children of his age.

There were also continuing difficulties with both reading and spelling difficulties, as well as problems with rate of written work. This was evident in Child H's profile of achievement test scores which is presented in **Table 8** below.

15. Child H—achievement test scores (February 2021)

Overall, while Child H's school reports indicated that he had made steady progress at school, response to intervention assessment provided evidence that difficulties with reading, spelling and rate of work were still evident, as well as classification of Child H's difficulties as linked to dyslexia. Firm classification could be made on the evidence that Child H had made good progress with reading comprehension but was still scoring well below age level on word reading, with continuing weakness in phonological and phonemic skills, as well as spelling. Rapid word recognition was also still below average.

As these areas of weakness were associated with difficulties with reading, spelling and rate of work which were ongoing as well as resistant to treatment, concessions at high school for reading, spelling and rate of work would be necessary. Ongoing

Subtest	Test measures	Standard Score	Age Equivalence
WIAT III Word Reading	Letter identification; phonological awareness; letter-sound awareness; accuracy of word recognition; automaticity of word recognition.	75	9 yrs. 8 mths
WIAT III Pseudo Word Decoding	Phonemic Decoding Efficiency	82	9 yrs. 7 mths
Edinburgh Reading Comprehension	Reading comprehension	93	12 yrs. 4 mths
WIAT III Spelling	One Word Spelling	82	9y8m
TOWRE	Sight Word Efficiency Phonemic Decoding Efficiency	85 83	9y6m 9y3m
Letter Chains	Rapid Letter Recognition	109	n/a
Word Chains	Rapid Word Recognition	89	10 yrs. 0mths

Table 8.
Child H: Achievement test scores (February 2021).

treatment of the areas of weakness in the profile would also be necessary, using methods which used Child H's high levels of spatial ability to address the continuing areas of phonological and phonemic weakness, as well as the continuing difficulties with rapid naming and coding.

16. Main trends in this case study

In the case study presented in this chapter, firm classification of type of learning disability was made at the end of Child H's primary school years, based on triangulation of evidence collected by use of different methods over time [84, 85], within a model of inference based on a process of incremental validity [17, 83]. Diagnosis was then linked to concessions to compensate for those areas of difficulty which have been demonstrated to be resistant to particular forms of treatment, as well as to ongoing treatment and learning support in particular areas of the high school curriculum.

Firm diagnosis was made possible by both longitudinal assessments using psychometric testing, as well as analysis of Child H's response to particular types of treatment intervention. These focused on a number of areas of difficulty identified by Child H's parents, including the following:

- Reading fluency difficulties.
- Guessing rather than analysing words, affecting both reading and rate of work.
- Spelling and phonic difficulties.
- Difficulties with phonetic spelling.
- Issues with writing and completing work.
- Difficulties with completing creative writing tasks.
- Lowered confidence due to awareness of difficulties.

These areas indicated the need for multivariate assessment as well as multivariate treatment, which was provided by the following:

- Use of Methods to Develop Reading Fluency.
- Use of Methods to Develop Phonological and Phonic Skills.
- Use of Methods Designed to Increase the Transparency of Written English.
- Use of Methods Designed to Improve Working Memory for Individual Words and Sequences of Words.
- Use of Methods to Develop Rapid Naming and Rate of Work.
- Use of Methods to Compensate for Spelling Difficulties through Computer-based Speech to Print Technologies.

Child H's difficulties were initially described functionally, as the basis for developing his treatment programme. This was implemented using formats which enabled focus on a number of treatment areas side by side using graded electronic materials which included.

- Phonically-based large print reading fluency books.
- Graded phonic and phonological referencing materials.
- Graded reading comprehension materials.
- Graded test-based written language materials.
- Graded working memory and sequential working memory materials.
- Graded test-based arithmetic and maths problem-solving materials.

Child H's treatment was thus multivariate and was implemented through weekly sessions with support from Child H's parents, who received illustrated electronic parent implementer manuals as well as weekly emails with supporting electronic materials for implementation at home. This enabled focus on the skills required to support Child H's work at school, as well as the classroom and homework tasks provided as part of his programme at school. It also enabled firm diagnosis of dyslexia, dysgraphia or dyscalculia to be made at the end of Child H's primary schooling career, based on evidence of his response to the classroom work included in his school programme, evidence of his scholastic attainments, as well as evidence of the development of his abilities in cognitive processing which took place side by side with the treatment interventions described in this chapter.

Detail in the case study has been provided with the aim of providing the reader with an idea of the different types of fluency-based methods and materials used in working with Child H over a number of years, as well as the way in which longitudinal progress evaluation has been combined with psychometric testing conducted at different points over Child H's primary schooling. This has enabled skill development to the stage where Child H has successfully made the transition to high school. It has also enabled firm diagnosis of dyslexia with the aim of motivating for a number of concessions.

The application for concessions has been successful at this point in Child H's schooling. He is confident in his abilities, coping well with his high school programme and excelling at sport. He also has a talent for maths, a talent for transactional writing in English and a love of poetry.

17. Summary and evaluation: can this case study be replicated?

Despite the limitations implicit in the analysis of single cases, a number of aspects of this single case (N = 1) design can be generalised, and are replicable by others.

17.1 Model of assessment

The model for response to intervention classification of learning disabilities described in this case study is multimethod, based on summative assessment linked to

progress evaluation of longitudinal interventions conducted across a number of areas of functional difficulty. While the assessments conducted with Child H have utilised the types of psychometric instruments commonly used in our country to provide indicators of underlying learning disabilities [6], the methods used and the types of evidence used for classification can be replicated.

For readers interested in assessment, there would also be good reason to do so. One reason is that use of repeated measurement linked to qualitative evidence collected at different data points over time would be likely to increase the likelihood of valid classification. The detail provided in this chapter would also indicate that a response to intervention approach to classification provides firm evidence that dyslexia is a type of learning disability which is likely to affect children throughout their schooling, for which concessions are not only advisable, but necessary.

This argument has been advanced by a number of other researchers and clinicians working internationally [20–22].

18. Methods of treatment

For readers interested in methods of treatment, this chapter has presented a longitudinal timeline documenting an approach to treatment which is essentially multivariate and eclectic, based on the combination of a number of treatment methods. The central focus of treatment has lain on the development of fluency in reading, writing and spelling based on the neuropsychological theories of automaticity proposed by Luria [1, 2] as well as the work on oral impress methods and paired reading first described by Heckelman [135–137] and then successfully implemented by others in the field [138–147].

A number of the treatment methods reflect the types of phonically based described by the body of researchers and clinicians who work from the standpoint that dyslexia is a severe difficulty with phonological processing [121, 148–153]. Other treatment methods are based on my previous work in the development of spatial perception using Piaget's theories [154–159] and focus on developing working memory for individual words and words in sequence using eidetic imagery [160, 161]. These methods use phonic analysis combined with VAKT and revisualisation-based techniques similar to those described by Fernald [27], as well as by others who have found it necessary to adapt other techniques in working with children [162–165].

The methods used are thus eclectic and based on use of combinations of graded reading, writing and spelling fluency activities, as well as use of methods targeting rapid naming and rapid reading and recall of words. They would accord with the types of multivariate curricular strategies suggested by Wolf and her colleagues [133–134]. They would also accord with the recommendations made by those researchers and clinicians who have suggested the value of linking the development of both skills and automaticity in reading, writing and spelling [107, 166–171].

At the same time, the methods used with Child H for developing writing and spelling fluency would appear to be unique in the literature. These are based on use of phonological referencing [106] as well modifications of the analytical techniques for teaching how words work based on seven vowels pioneered by Caroline [172]. As used in my practice, the seven vowel system applied in analysing and mapping the letter combinations used to represent vowels in English orthography is based on metacognitive strategies that have been logical to a number of children with severe learning difficulties [5]. What has been effective in enabling these children to code

from what you write to what you say, and to recode from what you say to what you write have also been logical in terms of research indicating evidence of a universal phonological principle, which would apply to learning to read the orthographies used in all languages, including pictographic written languages [173–176].

These methods may be of interest to others as use of a seven vowel as opposed to five vowel system enables direct coding and mapping of the letters used in written English to the sounds made in spoken English, with few exceptions. It also provides a basis for combining phonic analysis and revisualisation in developing working memory for individual words as well as words in sequence, as described in previous publications [6], and in this case study.

Overall, however, those readers who know the field well are likely to see the methods described in this case study as multivariate, eclectic and derivative of the pioneering work of Gates [25, 177], Monroe [178, 179], Orton and Gillingham [180, 181], Durrell [26] and Fernald [27] in stressing the importance of assessing and linking treatment of both phonological and visual aspects of reading disability to the development of working memory. In addition, they are derivative of the many other researchers and clinicians who have stressed the importance of linking the teaching of reading, writing and spelling with the development of working memory, whose contributions are acknowledged in the reference list.

As the practice materials are phonically based and made available for use electronically, the methods described in this case study can be and have been successfully worked with and adapted by parents, teachers and therapists through use of the types of activities described in our detailed manuals [8, 105]. They can also be replicated as the methods and materials described in this case study are available for implementation at low cost by others.

19. Aggregation with the results of other case studies

Children's problems vary, and no one size fits all. While this N = 1 case study would support this standpoint, there is also the potential of aggregation of N = 1 case studies with others. For readers with an interest in aggregative case survey research, one way to implement this type of clinically based aggregation is to use classificatory variables for purposes of grouping, comparison and contrast. This is being done in the author's practice on an ongoing basis as follows.

There is sufficient breadth of graded, phonically based material in the practice's data base to develop fluency-based programmes for children of different ages and with different pre-test levels of reading, writing, spelling and sequential spelling skill. Besides Child H, these materials have been used by the parents of a number of other children diagnosed as having learning disabilities manifesting in difficulties with reading, writing and spelling, as well as fluency-based difficulties.

As a number of additional children have used the same data base of materials as well as similar methods for developing reading, writing and spelling fluency, the case aggregative techniques described in a previous publication provide a basis for ongoing aggregation [6]. This used categorical variables to contrast the results of an opportunity sample of 20 children selected from the files of children with whom similar fluency-based programmes had been implemented over a three-year period with the results of other children exposed to differing types of fluency-based programme implementation.

Criteria for inclusion were that each of the 20 children had been diagnosed with a learning disability affecting reading, writing, and spelling, and also had fluency-based difficulties. Each child was also exposed to work in all three areas of intervention (reading, writing and spelling) of the fluency-based programmes described in this current chapter. Based on case contrast analysis with the results of 6 children on whom systematic variation in one or more area of programme implementation had occurred over the three-year period, a number of implementation variables were found to be likely to affect the successful implementation of our fluency-based work.

These variables were as follows:

- Consistent and regular exposure to phonological and phonic instruction to provide a foundation of basic skills on which the fluency interventions in our programme could be built;

- Consistent implementation of methods designed to improve both reading fluency, and writing and spelling fluency to produce the greatest likelihood of positive effects; and.

- Consistent support from parents in programme implementation to produce the greatest likelihood of positive effects.

Despite the many limitations and threats to validity implicit in aggregative case survey analysis, these results indicate the potential of using categorical variables for purposes of classification and contrast, as a basis for identifying central trends in multimethod data drawn from clinical work with children, and relating these to outcomes. The central trends reported above are of interest as each of the treatment variables applied in the types of fluency-based programmes used in working with Child H, in the case study presented in this chapter. Consistent implementation has also taken place. Consistent support from Child H's parents has been present over the entire period of programme implementation. The evidence of outcomes has also been positive.

20. Notes

Note 1. This has been described in a previous chapter which can be accessed *via* the following link:

http://mts.intechopen.com/articles/show/title/dyslexia-dysgraphia-and-dyscalculia-a-response-to-intervention-approach-to-classification

Note 2. The ICD-10 (International Statistical Classification of Diseases and Related Health Problems – Tenth Revision) is a diagnostic coding standard owned and maintained by the World Health Organisation (WHO) [182]. The coding standard has been adopted by the National Health Information System of South Africa (NHISSA), and forms part of the health information strategy of the South African National Department of Health (NDOH). The standard serves as the diagnostic coding standard of choice in both the public and private healthcare sectors in South Africa for morbidity coding under Regulation 5(f) of the Medical Schemes Act 131 of 1998 [183].

Note 3. Rob Stark, of the Centre for Therapeutic Excellence https://www.centrefortherapy.co.za

Note 4. The multivariate approach to assessment and treatment used in the practice has been described in a previous two part publication which can be accessed via the following links.

https://www.intechopen.com/books/learning-disabilities-an-international-perspective/developing-automaticity-in-children-with-learning-disabilities-a-functional-perspective-part-one-the

http://www.intechopen.com/articles/show/title/developing-automaticity-in-children-with-learning-disabilities-a-functional-perspective-part-two-pro

Note 5. Child H was educated in a government-funded primary school in the northern suburbs of Johannesburg, which are areas where parents usually lie in higher socio-economic bracket than parents in other residential areas, or the reason that as the city evolved, the eastern, western and southern suburbs were closer to the dust, pollution as well as the physical danger of underground blasting in the gold mines. As commercial gold mining has been phased out as the underlying gold-bearing reef has been exhausted, wealth distinctions affecting residential areas have become more blurred. As a result, the children in the author's practice come from a wide catchment area, with many parents travelling from the eastern, southern and western suburbs, and some parents travelling as much as 600 kilometres from out of town on a weekend to bring their children for assessment or to educational therapy sessions. Similarly, the referral and schooling network in the practice covers a wide geographical area. This is possible with the advent of email and cell phones, and this has been enabled by the fact that our reading, writing and spelling fluency materials and manuals are electronic.

Note 6. These were developed in the classroom in 1978 and 1979, while the author was working at Crossroads Remedial Centre and then at Norwood Remedial School. The initial research results were analysed in early 1979 and reported in mid-1979 [87], prior to the author joining the University of the Witwatersrand, Johannesburg. The Phonic Inventories were then implemented as one of the instruments used in research conducted at Japari Remedial Centre, Parktown, Johannesburg. The results were reported between 2005 and 2011 [89, 90, 98, 184, 185].

Note 7. In working with Child H and other children in the practice, my aim has been to link instructional activities to the child's cognitive style, which is defined as the ways in which each child thinks, perceives and remembers information. Child H's cognitive style was determined by listing areas of strength and areas of weakness from a number of indicators of how he processed information (e.g. areas of strength and areas of weakness in his cognitive and achievement test profiles) [186, 187]. Following Piaget [188], these indicators were then combined with observation of the successful strategies employed by Child H as well as errors made in working on activities involving use of perception, language, thinking and working memory. Areas of weakness and errors made then formed the targets for instruction, using methods based on Child H's strengths and the learning strategies he found to be effective in writing and spelling individual words and words in sequence. These were determined through action research based on observation, followed by evaluation and replanning.

Note 8. In terms of ICD DSM IV diagnosis [189], assessment of reading difficulties would normally be conducted on Axis IV, which would aim to identify psychosocial stressors, as well as psychosocial and environmental problems affecting reading ability on a functional level. Reading difficulties would then be classified under reading disorders, corresponding to ICD-10 code F81.0 and DSM-IV code 315.00, as follows:

A. Reading achievement, as measured by individually administered standardised tests of reading accuracy or comprehension, is substantially below that expected given the person's chronological age, measured intelligence and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require reading skills.

C. If a sensory deficit is present, the reading difficulties are in excess of those usually associated with it.

If a general medical (e.g. neurological) condition or sensory deficit is present, Axis III on the ICD DSM IV would also be used for classification purposes. This axis aims to identify underlying medical or neurological conditions which may influence reading ability (e.g. attentional or concentration difficulties, especially those associated with cortical immaturity, or slow myelinisation associated with poor connectivity).

Note 9. The diagnostic criteria corresponding to ICD-10 code F81.2 and DSM-IV code 315.2 for 315.2 a disorder of written expression are as follows:

A. Writing skills, as measured by individually administered standardised tests (or functional assessments of writing skills), are substantially below those expected given the person's chronological age, measured intelligence and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require the composition of written texts (e.g. writing grammatically correct sentences and organised paragraphs).

C. If a sensory deficit is present, the difficulties in writing skills are in excess of those usually associated with it.

As with Code 315.00, if a general medical (e.g. neurological) condition or sensory deficit is present, the condition would then be coded.

Note 10: This was done through use of standard scores linked to age equivalents.

Note 11: At time of writing this chapter there are between eight and nine thousand items in the practice's data base. These are graded, and test-based. As all of the materials are electronic, they can be sent out by email. This enables implementation of multivariate programmes based on use of our methods and materials both locally and internationally.

Note 12: Based on a points reward system suggested to me by Alex Bannatyne in 1977.

Note 13. Based on the author's work with Errol van der Merwe in developing three dimensional spatial perception working with engineering students at the University of the Witwatersrand over a 20-year period [155, 156, 158, 159, 188, 190–195], as well as work done over a 10-year period with children at Japari Remedial School, Johannesburg. This involved implementation of instructional procedures based on use of eidetic imagery in visualising and revisualising words [161, 196–198].

Note 14. The possibilities of using eidetic imagery in developing working memory for words are indicated by the author's clinical work using the Targeted Revisualisation and Sequential Spelling Programme with a number of children with reading, writing and spelling difficulties [5, 6], as well as by research done by Ravenscroft [161]. Ravenscroft used a mental imagery questionnaire based on procedures for visualising and revisualising words with a sample of 92 children at Japari Remedial Centre, each of whom had been diagnosed as having a learning disability. About 76% of children in the sample (70 out of the 92 children tested) were able to use eidetic imagery to visualise and revisualise words. Ravenscroft's research thus indicated the potential value of using revisualisation techniques in working with children with learning disabilities, as well as the high incidence of spatial competence in children with reading, writing and spelling difficulties. This provided support to my

own clinical work which has focused on combining phonological referencing, phonic analysis and revisualisation techniques in developing working memory for words, and sequential working memory for words [8, 105].

Note 15: It is important to note that my work has involved adaptation use of Fernald's techniques. Ravenscroft's research indicated that three out of four children in a sample of 92 children at Japari were able to use eidetic imagery for purposes of recalling words. At the same time, one out of four children in the sample was not high visualisers. For this reason, both visual imagery and other forms of mental imagery (e.g. reauditorisation or use of kinetic or tactile imagery) would need to be used in developing working memory for words.

At the same time, there were also indications from Ravenscroft's data that eidetic imagery was trainable. As Kasdon has pointed out, this is also implicit in the stages involved in Fernald's procedures. As Fernald has suggested [27], what is important is to develop the ability to look at the word and say it, to close one's eyes and use mental imagery to recall the word, then to say the word while holding the word in the mind with one's eyes shut (thus linking spoken language and mental image) and then to spell the word with one's eyes shut. It would also be important to test working memory through writing the word.

Following Fernald's suggestions, working memory for words as well as writing and spelling fluency would need to be developed in stages. It is also clear from Fernald's account (e.g. page 147), that visual imagery was not present with all the children she worked with at the start, but in a number of children developed through training. Individual children also adapted to the techniques in their own ways.

This has been the principle followed in my own work. As Kasdon has observed [162], the stages involved in using Fernald's techniques are not purely based on use of a kinesthetic method, but involve the development of a process of recall based on the child's particular use of mental imagery. The processes involved would be likely to vary from child to child. This is clear from the cases described by Fernald, and was the principle adopted in Kasdon's work at the Ferkauf clinic at Yeshiva University, as well as the principle adopted in working with Child H. This involved use of Fernald's techniques as a framework, which was then adapted to fit Child H's cognitive style and his individual ways of learning.

Note 16. Use of a format system enabled work to be conducted with Child H in a number of areas, and supported by work done at home. The format system was also used as the basis for the work done with other children online during COVID [8].

Note 17. Learning the spelling of words using occlusion involved a technique in which a word was written on the left hand side of the page, looked at and then covered with the hand while being written in the middle of the page. Both hands would then be lifted, and the words checked for consistency and accuracy. Both words would then be covered with the hand while the child tested him or herself by writing the word for the their time on the right hand of the page. Both hands would then be lifted, and the word marked by the child as correct or incorrect.

Note 18. As in the clinical work described by both Fernald and Kasdon, test information was combined with use of observation of the strategies used by Child H in remembering words. In working with Child H, grade and age scores from the Durrell tests of visual memory for words and phonic spelling of words were used as indicators of competence in using visual and auditory memory for recalling words. These were interpreted in conjunction with observation of the processes Child H used for revisualising words, and then writing these words from memory. Once the revisualisation process was well established, this was then extended into rapid reading

of words combined with work on recall of words read rapidly using an electronic tachistoscope.

Note 19. In terms of ICD DSM IV diagnosis, there was evidence that Child H had reading difficulties which has continued over a number of years. This implied diagnosis on Axis IV, which would aim to identify psychosocial stressors, as well as psychosocial and environmental problems affecting reading ability on a functional level. This could then be classified as either ICD 10 Code F 81.3 relating to a continuing and long-term reading disorder, or ICD 10 Code Z 73.3 (stress not elsewhere classified).

Note 20. The diagnostic criteria corresponding to ICD-10 code F81.2 and DSM-IV code 315.2 for 315.2 a disorder of written expression also still applied, based on assessment of Child H's writing and spelling skills, as measured by individually administered standardised tests (or functional assessments of writing skills) are substantially below those expected given Child H's chronological age, measured intelligence, and age-appropriate educational reports from his school.

Note 21. The three levels of the Phonic Inventories focus on use of consonant blends in words based on short vowel sounds, use of vowel digraphs and use of morphological endings in polysyllabic and compound words based on short vowel sounds.

Note 22. The diagnosis of dyslexia linked to the ICD 10 diagnostic criteria was made by Robert Stark, of the Centre for Therapeutic Excellence. This was based on analysis of psychometric test data, combined with longitudinal analysis of school reports. In addition, Child H's response to intervention over the same period provided clear evidence of the need for concessions in reading, spelling and rate of work.

Note 23. A number of children in the practice have been using tachistoscopic methods for development of rapid reading as well as working memory for words. The response to use of these methods has been very positive. Child H, for example, reports that work on the tachistoscope has contributed to better processing of written material as well as more rapid cognitive processing more generally. Similar comments have been made by other adolescent boys and girls in the practice, indicating the potential of tachistoscopic work to address rapid reading of words as well as working memory for words read quickly.

Note 24. A level of literacy is defined as attainment of reading, writing and spelling age scores of between 12 and 13 years on achievement tests.

Note 25. Based on Child H's verbal and written evaluation comments.

Note 26. Robert Stark, of the Centre for Therapeutic Excellence., https://www.centrefortherapy.co.za

Note 27. The WISC, WISC-R, WISC IV and WISC V all use identical symbols and presentation formats in the coding subtest. The implementation procedures and timing of the test have also remained unchanged through all the different restandardisations of the WISC.

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