In 1991 in her book 'Overcoming Dyslexia' Dr Beve Hornsby described the effect of Dyslexia as being,

'As though a confusing traffic jam of nerve cells builds up in the corpus callosum between the language areas of the brain, complicating the Dyslexic's understanding of verbal or written speech.'

And she went on to write that;

'In line with this theory recent research in 1981 by Dr Albert Galaburda and Dr Thomas Kemper from Boston USA has brought to light noticeable anatomical differences between the dyslexics' and normal readers' brains'.

In 1996, Uta Frith and her team at the Medical Research Council's Cognitive Development Unit in London, used Positron Emission Tomography to study the brain's most active areas whilst individuals processed linguistic tasks. This was specifically related to ascertaining whether Dyslexia was due to a difference in the structure of the brain. Dyslexics and non dyslexic volunteers were tested. Rita Carter of the Scientist magazine reported,

'The Pet scans showed differences in two parts of the brain which are in the left perysilvian area - a chunk of cerebral cortex just above the ear. This contains Wernicke's area which is thought to be involved with the recognition of complete written words and Broca's area which breaks down the same words into segments and creates a mental image of the sound. There is also a lump of tissue called the insula. The PET scans suggest that the 'insula' forms a crucial bridge between the two areas. In the non dyslexic volunteers, the insula lit up and both language areas lit up together during the linguistic tasks. In the dyslexics this did not happen and each language area was activated in isolation.'

The New Scientist, in an article titled, 'Dyslexia's roots traced to bad brain connections' describes a study carried out by Bart Boetes and his team at the Catholic Leuven University in Belgium in 2013. The teamed scanned 23 adult dyslexics and 22 non dyslexic adult's auditory cortex and all the participants exhibited normal nerve activity when responding to various speech sounds.The team then explored the connections between 13 brain regions involved in language processing. They assessed both the functionality of these regions and

the structure of the actual nerves that connect these regions. In people with Dyslexia both these measures revealed faulty connections between the superior temporal gyrus-the area that contains the auditory cortex and the inferior frontal gyrus-a region involved with langauge processing and speech production.The worse the functional connection between the two tasks the worst the individual's performance on reading and other phonological tasks. Taken together the measures predicted whether the individual was Dyslexic or not, with 73% accuracy.

Research into the causes of Dyselxia has come a long way since Doctor W. Pringle Morgan first referred to a case of 'congenital word blindness' in the British Medical Journal in 1896. There is no cure for Dyslexia, but targeted support helps children and young people to acquire more secure literacy skills. In order to find out which children and young adults may benefit from very specific support using multi sensory teaching methods we need to use precise tools to assess their underlying cognitive processing skills.

SEND CODE OF PRACTICE, 2015

The SEND Act 2015, (Special Educational Needs and Disabilities Act) states that specific learning difficulties such as Dyslexia are recognised disabilities with definite needs, and as such they are covered in the act. The Act states that schools should,

'Assess children's current skills and levels of attainment on entry, building on previous information from previous settings and key stages where appropriate. At the same time schools should consider whether a pupil may have a disability under the Education Act 2010 and if so reasonable adjustments should be made'. And the Act goes on to say that,

'Assessments should be reviewed regularly. This will ensure that support and intervention are matched to need, barriers to learning are identified and overcome, and that a clear picture of interventions put in place and their effect is developed.'

The common factor that people with Dyslexia present with is that they struggle to read easily and they find it hard to express themselves in writing. Dyslexia is a specific difficulty decoding and encoding letters into words. In 2009 Professor Jim Rose (who had been asked to produce a report about Dyslexia for the then Labour Government) described Dyslexia thus:

'Dyslexia is a specific difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling. Characteristic features of dyslexia are difficulties in phonological awareness, verbal memory and verbal naming speed. Dyslexia occurs across the range of intellectual abilities.'

Since 2009 this description of Dyslexia has tended to be used by local authorities when assessing whether the child or young person in question is struggling due to Dyslexia. And certain phonological awareness skills may be assessed and if found to be at average levels, no further assessment may be carried out. Not all phonological awareness skills tests are timed. Jim Rose does not single out phonological awareness, he also includes, verbal memory and verbal processing speed. Phonological awareness is the ability to discriminate individual speech sounds. Phonological memory tests assess the ease by which individuals can recall digits and non-words in the short term. And Rapid Symbolic Naming tests assess the individual's ability to read individual letters and digits aloud. This involves the individual linking their long term recall of letter sounds and digits names with their ability to recognise the letter or digit that is has been coded with. 'Rapid naming of objects, digits or letters requires retrieval of phonological information from long term or permanent memory.' (Wagner Torgesen and Rashotte, 1999)

Study

In 2014 I decided to carry out a small study to see how ubiquitous weak 'Phonological Awareness' and 'Phonological Memory' difficulties actually are in relation to weak 'Rapid Letter Naming' speed and Phonemic Decoding ability in diagnosed children and young adults diagnosed with Dyslexia. 14 sets of scores of students aged between 8 – 23yrs old were analysed. These students had all been assessed as Dyslexic over the previous 3 years using the same set of accepted standardised tools. All the students were native English speakers with native English speaking parents to rule out cadences affecting ease of assimilation of English letter sounds. The sample group were either wearing prescribed glasses or recently assessed as having normal vision and had been screened and assessed as non-sensitive to glare, which may be described as 'Mears Irlen' Syndrome.

RESULTS

The mean General Visual Perceptive ability of the sample group using the Wide Range Ability Test (WRIT) was at the high average level at standard score: 112 (score span being: Standard Score 94 - 122). The mean General Verbal ability of the group was at standard score: 110, on the cusp of high average ability (score spans being between, 90-125). The sample group were all given the sub-test in the Phonological Awareness test, Elision, which forms part of the Comprehensive Test of Phonological Processing Test, known by its acronym, CTOPP; which has now been superseded by, CTOPP 2. The 'Elision' test requires the student to listen to a compound word such as 'homework' and then work out the remaining real word if 'work' is removed. The test progresses until the student is asked to say the real word left over when a single speech sound is removed. The mean score achieved by the group was standard score: 101, which is mid-average ability. The span of the scores was Standard Score: 66-105 and 10 of the 14 standard scores were at the average level. Four of the 14 Dyslexic individuals had below average Phonological Awareness.

CTOPP incorporates a test of immediate Phonological Memory called the 'Digit Memory Test'. The individual is asked to repeat increasingly longer strings of non-sequential digits. The mean score of the sample group was standard score: 92 which is at the average level; the span of scores being from Standard Score: 66 -130+ and 11 scores were at the average level and above. Three of the fourteen individuals had a below average Phonological Memory. The CTOPP Rapid Letter Naming Test results were interesting in that all the individual scores were at or below standard score 90, which is on the cusp of low average, giving a mean standard score of 76 which is below average. Thus from the results of this tiny study, Rapid Letter Naming appeared to be the only phonological processing skill, within the CTOPP test, which was consistently low or below average in all the Dyslexic students in the study regardless of their general ability.

The cohort's reading rate and proficiency had been assessed using the TOWRE (now superseded by TOWRE 2) which is the acronym for the Test of Word Reading Efficiency. This test measures the rate and accuracy of the participant's reading of a list of increasingly complex single words. All the participants' scores were below average and their mean Standard Score was 83. And the TOWRE test also has a Non-Word Reading test which, as

there is no possibility of sight reading the Non Words, is a very useful way of assessing phonemic decoding ability All the results for this test were below average and the mean result for this test was Standard Score: 82. Thus below average, Phonemic Decoding skill, was a factor in all the Dyslexics score profiles. And below average Rapid Letter Naming was a factor in 13 of the 14 score profiles. Below average Phonological Awareness was a co-existing factor with below average Phonemic Decoding in 4 of the 14 profiles and below average Phonological Memory was a co-existing factor with Phonemic Decoding in 3 of the score profiles.

New Study, 2016

The results of the assessments of 10 students aged between 9 -18 years old were analysed to look at the common difficulties that had led to them being diagnosed as being Dyslexic. A wider set of assessment tools was analysed. Again the precise sets of results was chosen because the students involved were not affected by co-existent factors which could influence the results, such as hearing or visual difficulties. The individual's visual motor integration (relevant to handwriting) had been screened using the Beery Visual Motor Integration Test V1 or/and the Detailed Assessment of Handwriting, DASH, Graphic test. And all the students achieved average Attention and Concentration scores using the Test of Memory and Learning 2's Attention and Concentration Index. All the individuals had been found to have average or above average General Visual and Verbal ability assessed using the Wide Range Intelligence Test, WRIT. The 'Gray Oral Reading Test V' (GORT V) which assesses the rate of the reader's oral reading of passages was added to the set of tests previously used in 2014. The Wide Range Attainment Test 1V, Single Word Spelling Test was used as before. The latest versions of the CTOPP, the CTOPP 2 and the TOWRE, the TOWRE 2, were used to keep the data as current as possible. The results of the Detailed Assessment of Speed of Handwriting, known as, DASH, which assesses Free Writing Speed, were also added to the study.

Reading and Non Word Test Results

The TOWRE 2, Word Reading TEST produced a below average group mean Standard Score of 78. The score span was Standard Score: 66-84, making all the scores below average. The TOWRE Non-Word (Phonemic Decoding) test produced a mean Standard Score of 82, the

score span was Standard Score: 79-85, making all the scores below average, bar one. Standard Score 85 is described as low average, despite being one standard deviation below average. The Gray Oral Reading Test V, which assesses passage reading rate as opposed to single words, produced a mean Standard Score of 82, which is below average. The test span of scores was 80-90. Eight of the scores were below average and two were at the low average level. Context appears to have aided some of the readers, but not all of them, and the scores underline why Dyslexics benefit from more time to read questions and their written answers in examinations.

In this investigation the ten individuals were given both the sub-tests, Letter and Digit Naming, which are aspects of the CTOPP 2, Rapid Symbolic Naming Ability. The mean Standard Score was: 71 and the score span ranged from Standard Score: 55-88 making 9 of the 10 Standard Score results below average and 1 at the low average level. The first study, which simply incorporated the Letter Naming aspect of the sub-tests, produced 13 out of 14 below average results, and 1 low average result and the mean Standard Score was: 76. So 22 out of the 24 Dyslexics achieved below average Rapid Naming Test results. And 2 achieved low average scores.

Phonological Memory Results

The CTOPP 2 test of Phonological Memory consists of 2 sub-tests and both were used in this study to provide composite standard score results. Beyond the Digit Memory Test used in the first study, the Non-Word Memory Test was used. The participant listens to a series of increasingly complex single non-words, and is asked to repeat the word immediately after dictation. The mean Composite Standard Score of the ten individuals was 88 and the test span of scores was 70 -119, which proved to be almost as variable as my first study reported above, although this study included simply the Digit Memory test. Three of the results were below average, 3 were low average and 4 were average or above average.

Phonological Awareness Results

The three individual sub-tests of the CTOPP 2, Phonological Awareness Test were used, as opposed to the single Elision Test used in 2014. 'Word Blending' is a test in which initially single letters sounds are dictated to the listener who is tasked with saying the whole word this creates. The test continues until complex polysyllabic words are included. The final sub-test

is called Phoneme Isolation, which probes the listener's ability to detach single phonemes from increasingly complex words. The group achieved a mean Composite mean Standard Score of 92 for the test set, and the score span was 84 -100. Two of the scores were below average, 1 was low average and 7 of the scores were average. Very clearly from this set of results, and the initial study in 2014, below average Phonological Awareness may co-exist with below average Rapid Naming ability but it is not prevalent. Mirroring this small study, the authors of the CTOPP 2, Wagner, Torgesen, Rashotte and Pearson, summarise the researchers listed below as arriving at the conclusion that,

' It is clear that rapid naming tasks predict poor performance in reading and they do so independently of measures of phonological awareness.' (Bowers and Swanson, 1991; Lervag and Hume, 2009, Manis Doi and Badha, 2000, Parrila, Kirby and McQuarrie, 2004, Powell, Stainthorp, Stuart, Garwood & Quinlan, 2007)

In the study reported here, the Non-Word TOWRE test which assesses, phonemic decoding skill produced 23 below average results and one low average result out of the full 24 sets of results. And the Rapid Symbolic Naming test produced 9 below average results out of 10 in the second study and one low average result. (This cannot be directly compared to the first study as only a single test was used). Both Phonemic Decoding and Rapid Symbolic Naming are tests involving reading, unlike the Phonological tests, awareness and memory, which are not as continually predictive of Dyslexia. We first learn to read by whole word recognition, recognising words from picture books, we then move to the alphabetical stage of reading, by identifying letters and their sounds and over time we gradually move to fluent reading as we effortlessly sound out letter groups, having assimilated the underlying rules which govern spelling & having mastered their myriad exceptions. So it is surely inevitable that below average letter recognition speed will create disfluent and or slow reading.

The Visual Aspect of Rapid Letter Naming

Prior to an assessment with me, individuals have been asked to have their vision tested and are asked to wait until their glasses arrive, if they require a prescription. When they arrive they are then screened for Mears Irlen Syndrome, which is sensitivity to the glare of black ink on a white ground which makes letters move or become distorted. This screening is carried out by

giving the participant a set of colour overlays which are placed over text to take away the glare of the white ground and in people struggling with hyper-sensitivity to glare, the correct colour overlay can dramatically transform their reading of letters and words. This is clearly a brilliantly simple and transformative solution for some lucky people. But the students with both Mears Irlen Syndrome and Dyslexia will read the letters slightly more speedily and clearly but they still struggle to read at average rates and their rapid letter and digit naming speeds are still below average.

'Rapid naming tasks assess the operation of a precise timing mechanism that is important for the developing knowledge of common letter patterns in printed words' (Bowers and Wolf, 1993, Wolf 1991)

A study published in 2014 investigated the eye movements of university students with and without reading difficulties during naming speed tasks. Eye movement methodology was combined with 3 letter naming tasks. Their conclusion was that;

'The naming speed and reading relationship was due to two factors: less able readers require more time to acquire stimulus information during fixation and they make more saccades.' Dahhan, Georgiou, Hung, Munoz, Parilla and Kirby, 2014

The extra 'fixation' time required by 'less able readers' in the quote above, is described by the research team listed, as attributable (but not provably so) to the reader needing increased time to link the image of the letters to their sound. Saccades are eye movements between fixations. This is an interesting study and would certainly account for the persistence of slow naming skills and slow reading in people who do find colour overlays help them but who still find reading very demanding.

The Phonological Aspect of Rapid Symbolic Naming Speed

The phonological aspect of letter and digit naming is hard to precisely extrapolate out of the test in any other way than placing it squarely on the shoulders of long term recall of letter and digit sounds. Separate short term phonological memory tests produce mixed results as is very apparent from my studies described above. Some but not all Dyslexics develop very efficient verbal memory skills because they cannot read instructions quickly; so school life exercises

their phonological/verbal memory skills daily! Both the CTOPP 2, Phonological Memory tests cue the listener as to the sound being recalled, as both tests require the participant to repeat dictated words and non-words. So the tests do not mimic the phonological aspect of the Rapid Letter and Digit Naming Test, and Non Word Decoding in which the participant's cues are simply the visual images of the letters and digits. Thus it is, long term recall of letter sounds and words which is being tested alongside visual recognition in Rapid Naming tasks and Phonemic Decoding.

Spelling & Free Writing Rate

The consistently below average Free Writing rate in nine of the ten sets of results in the second study is interesting. This was assessed using the DASH (Detailed Assessment of Speed of Handwriting) ten minute test. This test tasks the participant with writing about any aspect of their life for 10 minutes, making it a very accessible assessment which provides Standard Scores starting from the age of nine years old. Obviously, slow Free Writing, is a recognised aspect of Dyslexia and as an assessor I am very aware that it is a common factor. But compiling this set of test results has highlighted its prevalence, well above Phonological Awareness and immediate Phonological Memory. And the group's copying speed was not consistently below average, meaning it is their ability to recall and encode words that is the omnipresent issue, the mean Free Writing rate Standard Score was below average at Standard Score: 80. Free Writing, is partly a test of coding long term recall of letter sounds into words without an exterior verbal cue. The 10 individuals were not consistently poor spellers and spelling tests consist of a succession of dictated single words, so the listener is given a verbal cue. The Wide Range Attainment Test 1V, Single Spelling Word test was used and two of the ten individuals achieved below average Standard Scores and eight of the group's scores were within average limits, although below their General Verbal and Visual Ability. The mean Spelling Standard Score was 90 which is on the cusp of low average. The Free Writing test simply assesses writing rate not spelling. But the strain of writing sentences as opposed to single words make some people with Dyslexia (if they struggle with spelling single words) spell some high frequency words incorrectly that they spelt correctly from dictation. Free writing shares at least one of the aspects common to Phonemic Decoding and Rapid Letter Naming, it requires the linking of long term Phonological Recall to letters.

Conclusion

Learning to read extends visual acuity simultaneously. Reading every day strengthens the reader's skills in multi-faceted ways. The reader's visually acuity develops as they scan the words on the page. And as we read we develop our working memory and our receptive and thus our expressive vocabulary. If a child cannot interact with words on a page they are being left out of all the benefits reading brings. Using multi-sensory teaching methods designed to support the Dyslexic learner's specific skill set, slowly creates a network of neural connections that works for the individual child. This may take a while and the individual may always read more slowly than the average person but they will be reading. Not giving children at school who present as being Dyslexic the correct support because they have not been assessed regularly with adequate current assessment tools, is not only against the intrinsic right of every child as stated in the SEND ACT 2015 but it is taking the world of books away from them, what can possibly be the point in that?

References

Hornsby, B., (1995) Overcoming Dyslexia, pages 167-168

Wagner, R.K., Torgesen, J.K., and Rashotte, C.A. (1999) the Comprehensive Test of Phonological Processing

Bowers, P.G., and Swanson, L.B., (1991) Naming speed deficits in reading disability: Multiple measures of a singular process. Journal of experimental child psychology, 51, 195 – 219

Manis, F., Doi, L.M., and Badha, B. (2000) Naming speed, phonological awareness, and orthographic knowledge in second graders. Journal of Learning Disabilities, 33, 325 – 333

Parilla, R., Kirby, J.R., and McQuarrie. (2004) Articulation rate, naming speed, verbal short term memory and phonological awareness: Longitudinal predictors of early reading development, scientific studies of Reading, 8, 3-26

Powell, D., Stainthorpe. R., Stuart, M., Garwood, H., and Quinlan, P. (2007). An experimental comparison between rival theories of rapid automatized naming performance and its relationship to reading. Journal of Experimental Child Psychology,

Bowers P.G., and Wolf, M, (1993). Theoretical links between naming speed, precise timing mechanisms and orthographic skills in Dyslexia. Reading and writing an interdisciplinary journal, 5, 69-85

Wolf, M, (1991) Naming Speed and Reading: The contribution of the cognitive neurosciences. Reading Research Quarterly, 26. 123-14 Dahhan N.A., Georgiou.G.K. Hung.et al. Ann. of Dyslexia (2014) 64.137.doi:10.1007/s11881-013-0090-z