Neurodiversity and Dyslexia

Abstract

Although usually defined as a learning disorder that is specific to reading, dyslexia reflects natural variations in neurological processing of the visual form of words and their associated sounds. Recent advances in neuroscience show that in learning to read we ‘reuse’ parts of the brain that are initially involved in face and object recognition. This way of thinking about reading may help de-emphasise dyslexia as a ‘disability’ while furthering our ability to support students for whom reading is challenging.

Biography

Nuala Brady is an Associate Professor of Psychology at UCD and Vice-Principal for Graduate Studies in the College of Social Sciences and Law. Her research is in the broad area of visual and social cognition, and includes work on the recognition of faces, bodies and gestures. Her recent research on word processing in dyslexia uses experimental procedures associated with the study of face perception to explore the nature of visual processing in dyslexia. She is grateful to the staff at UCD Access and Lifelong Learning (ALL) and to students registered with ALL for their participation in her research.

Main Text

The term ‘neurodiversity’ describes one approach to understanding differences in cognition, behaviour and learning. Key to this approach is the idea that various neurological conditions - including dyslexia - reflect normal variation in our genetic makeup (Jaarsma & Welin, 2012). Crucially, the approach emphasises the need to understand and accommodate these differences in society. In the case of dyslexia the societal institution of education is paramount; from early readers in primary school to accomplished readers at university, neurodiversity means that some students will require extra supports to achieve the complex, cultural skill of reading.

Dyslexia is characterised by marked difficulties in learning to read that cannot be attributed to low intelligence, to poor motivation on the part of the child who is learning to read, or to a lack of education and opportunity to read (Conway, Brady & Misra, 2017). The incidence of dyslexia among school children is estimated to be between 5% and 10% (Stein, 2001), and it persists beyond childhood into adolescence and adulthood. College students may experience particular difficulty as they encounter new vocabulary and terminology during their university education (Shaywitz, 1996).

Our understanding of dyslexia is greatly enhanced by thinking more generally about the cognitive skill of reading. The human brain appears to be ‘hard wired’ for certain perceptual and cognitive skills such as face recognition and spoken language, and babies learn to recognize others and to communicate with them early and effortlessly. In contrast, reading might be conceptualized as a ‘cultural invention’ (Dehaene, 2009) for which we are not prepared by evolution. Learning to read requires years of formal instruction as children come to link the sight of a printed word (orthographic processing) with its sound or pronunciation (phonological processing). Alphabetic writing systems date from ~1500BC (Andrews, 2012) which is ‘recent’ in the history of human evolution, and the characteristics of the world’s various writing systems reflect the requirement that they are easy to recognize and to produce (Changizi & Shimojo, 2005). This ease of recognition and production refers to ‘neurotypical’ processing and leaves open the possibility that reading and spelling may be challenging for people whose visual or phonological processing varies from the norm.

Literacy, the ability to read and write, is a measure of a population’s education (Roser & Ortiz-Ospina, 2018) and universal literacy levels have risen from ~12% in 1820 to ~86% in 2015 (https://ourworldindata.org/literacy). This statistic is particularly interesting when we consider reading, and by extension dyslexia, from a neuroscience perspective. For example, if we ask which parts of the brain are involved in word recognition, then we are prompted to ask about the function of these parts of the brain before an individual child learns to read, or indeed, before an entire population learns to read.

Recent advances in neuroscience, particularly by Dehaene and colleagues (Dehaene, 2009) show that there is a specific part of the cortex in the left hemisphere of the brain - now known as the Visual Word Form Area (VWFA) – that is crucial to the recognition of individual words. Like the analogous area in the right hemisphere, this region is initially involved in face and object recognition but acquires the specific function of word recognition as a child learns to read. The idea that the brain ‘reuses’ or ‘recycles’ brain circuitry is an exciting one for psychologists as it allows us explore similarities in how complex stimuli such as words and faces are processed.

The starting point for our own research in this area is the observation that recognition of words and faces present similar challenges to the visual system. Both are made up of parts, features (eyes, nose and mouth) in the case of faces and individual letters in the case of words. Spatial configuration - the specific way in which these parts are arranged – seems very important to recognizing individual faces and individual words.

Figure 1 reproduces a variant of the ‘Thatcher illusion’ (Thompson, 1980) but using an image of former British Prime Minister Tony Blair, who is shown in upright and inverted orientations. The image shown in the familiar upright orientation is thought to activate regions of the cortex that are sensitive to the spatial configuration of the features in the face; therefore the distortion is obvious and rapidly perceived. In contrast, inverted images are thought to activate regions of the cortex that process in a more analytic, feature by feature basis; therefore, the distortion is not so apparent, and it takes us longer to discover what is wrong with the face.

Figure 1 An image of Tony Blair which has been distorted by inverting the eyes and mouth. The distortion is much easier to see in the upright image on the right than in the inverted image on the left. One explanation for this effect is that the visual system is sensitive to facial 'configuration' (the spatial relations between the features) at upright orientations but resorts to an analytic style of processing when the face is inverted. Image available from **www.viperlib.com**.

Applying the same logic to words, it should be much easier to recognize errors in words or to say whether a pair of words are the same or different when they are in the familiar, upright orientation than when inverted. In a recent study we presented UCD students, half of whom had a diagnosis of dyslexia and were registered with ALL, with pairs of word and asked them to judge, as quickly as possible, whether the words were the same or different (Conway et al., 2017). The stimuli included 4- and 5-letter words presented in both upright and inverted orientations and words which were intact or in which the letters had been jumbled (Figure 2). As shown in Figure 3 the students with dyslexia were as fast as their peers when the task was most difficult (in the inverted conditions) but they were considerably slower than their peers when the task was easiest (in the upright conditions). This suggests that analytic visual processing is intact in those with dyslexia but that, while they clearly do benefit from seeing the stimuli in the normal upright orientation, they do not benefit as much as typical readers. This is likely due to the fact that the students with dyslexia rely to a greater extent on slower, analytical processing during reading.

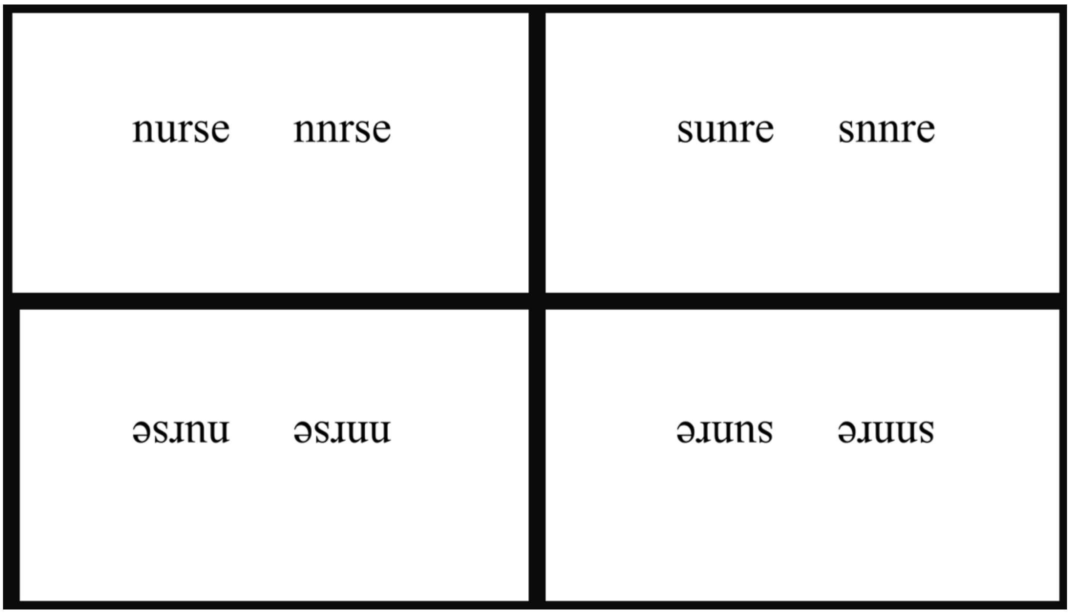

Figure 2 Examples of upright real (upper left), upright jumbled (upper right), inverted real (lower left), inverted jumbled (lower right) stimuli all made from the word ‘nurse’. In this example the pairs differ by one letter. In the study both same and different trials were used.

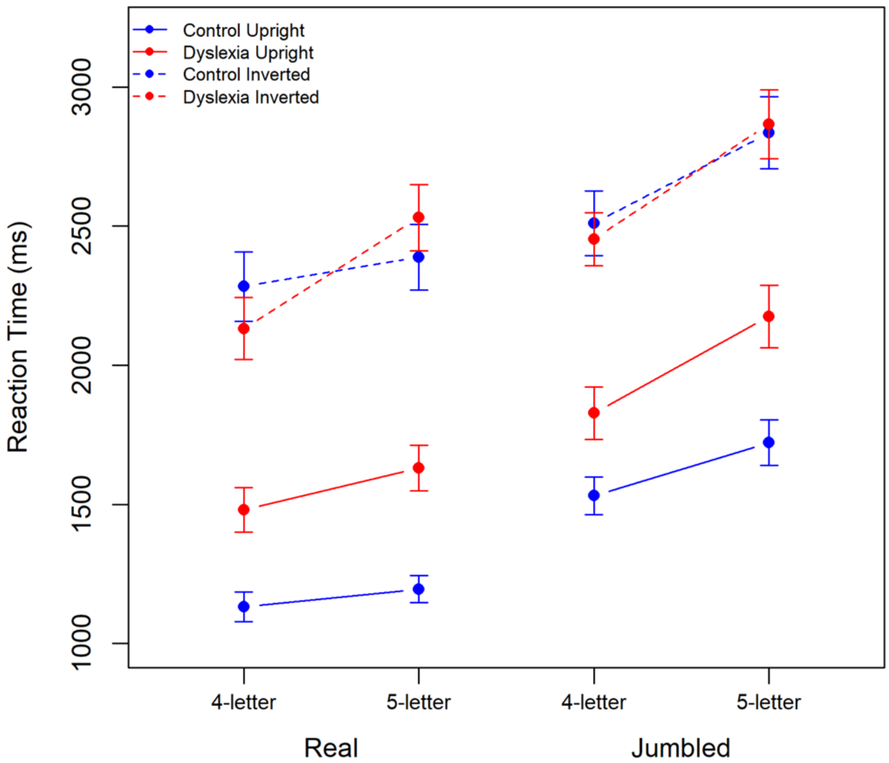

Figure 3 Performance, measured by reaction time, was better when stimuli were upright than inverted, showing the advantages of configural processing. While students with a diagnosis of dyslexia were as fast as their peers when the task was most difficult (the inverted conditions) they were considerably slower than their peers when the task was easiest (the upright conditions).

The implications of this and related research for supporting students with dyslexia are numerous. First, as analytic processing is slower than configural processing, students with dyslexia will likely need more time to complete examinations that are based on reading. Secondly, as ‘configuration’ refers to orthographic structure in the case of reading, students with dyslexia may be less fluent at spelling and will benefit from spelling waivers. Thirdly, conceptualizing dyslexia as a mismatch between aspects of visual and phonetic processing and the specific requirements of reading helps us appreciate that there may be considerable variability among students with a diagnosis of dyslexia as to the specific supports they require. Finally, it is important to remember that neurodiversity exists before we learn to read and does not go away when we learn to read. Therefore, an important support for students with dyslexia is to educate their teachers of their continuing needs in university.

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