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Master of Research Thesis

TITLE:

Strengths, challenges, and learning strategies of students with dyslexia at Australian universities: An online mixed-methods survey

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LIST OF ACRONYMS

Acronyms for participant groups

D-A	Dyslexia formally assessed
D-S	Dyslexia self-identified
HRD	History of reading difficulties
ND	Non-dyslexic
NLD	No learning disability
SLD	Specific learning disability

Acronyms for statistical terms

ANOVA	Analysis of variance
GEE	Generalised estimating equation
SD	Standard deviation
SEM	Standard error of the mean

TERMINOLOGY AND STYLE NOTES

Terminology and style choices throughout this thesis have been shaped by the principles of respect and empowerment for research participants and study populations put forward by social and educational inclusion advocates (Charlton, 1998; Oliver, 1991).

First, overall 'Plain English' terminology has been used. Academic jargon is avoided as much as practical. Where academic terms are needed for precision or efficiency, they are clearly defined.

Second, non-medical words such as 'difference', 'characteristics', 'formal assessment', and 'co-existing' are used, rather than medical terms such as 'disability', 'symptoms', 'diagnosis', and 'co-morbid'. These choices reflect adherence to the neurodiversity framework that casts diverse learning abilities as differences rather than disabilities (Alexander-Passe, 2018; Armstrong, 2015; Cooper, 2009). The word 'disability' could not be eliminated entirely, particularly when citing other papers. Wherever possible, however, medical language is rejected in favour of positive, non-medical terminology.

Third, diagrams have been used where relevant to illustrate complex concepts. They are intended to improve accessibility and understanding for a wide audience, especially people with dyslexia.

Finally, some standard scientific style conventions have been rejected to enhance readability. For example, statistics have been expressed with all zeros included, i.e. '$p < 0.05$' rather than '$p < .05$'. This improves readability for the author, who is dyslexic, and it is hoped it will improve readability for others too.

ABSTRACT

Dyslexia generally affects reading and spelling, but not intelligence (International Dyslexia Association, 2018). Students with dyslexia can succeed at university, but related challenges can affect wellbeing and attainment (Alexander-Passe, 2015; Mortimore & Crozier, 2006; Richardson, 2015). Research literature has described many potential strengths and learning strategies of students with dyslexia, which could help overcome challenges (MacCullagh et al., 2017; Pino & Mortari, 2014). However, few quantitative comparisons have been conducted between dyslexic and non-dyslexic groups, nor between different learning strategies. Thus, it is not known if university students with and without dyslexia differ significantly on academic strengths, challenges, or learning strategies. Nor is it known if students with dyslexia consider any specific strategies more helpful than other strategies. To begin resolving these uncertainties, an online mixed methods survey was conducted, recruiting 70 students with dyslexia formally assessed (D-A) and 58 non-dyslexic peers (ND) from Australian universities. Reported academic strengths were not found to differ significantly between groups. However, average difficulty ratings by the D-A group were significantly higher than for ND peers across all learning and assessment activities surveyed, except essay exams. The D-A and ND groups also differed significantly in usage proportions for some learning strategies, but not on average helpfulness ratings for any strategy. Ranking overall perceived helpfulness of learning strategies for D-A participants by combining usage proportions and average helpfulness ratings for this group indicated 'Reducing Contrast' as the highest ranked strategy, and 'Special Font' the lowest. These quantitative findings were supported by qualitative comments. University students with dyslexia can use evidence from this study when considering which learning strategies to implement. University staff, researchers, and policymakers can also use findings of this study to inform their decisions. Such applications of the study findings could ultimately improve wellbeing and success of university students with dyslexia.

STATEMENT OF ORIGINALITY

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

(Signed)  Date: 11/7/2020

Candidate's name

DEDICATIONS

I dedicate this thesis to the memory of my mother, Janice MacCullagh. Despite strongly believing university degrees to be unnecessary and ill-advised, she would have supported me wholeheartedly every step of the way. I was blessed to be her daughter. Everything is more difficult without her.

I also wish to express my never-ending gratitude to my early primary school teachers: Mrs Verna Jones, Mrs Pamela Mewitt, and Mr Peter van Dort. I owe much of my professional and academic success to their amazing skills teaching me and my whole class to read. I'm sorry all children can't be taught by them!

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CHAPTER 1: INTRODUCTION AND CONTEXT

This thesis builds on the body of scholarly research regarding strengths, challenges, and learning strategies of students with dyslexia at university. It provides new quantitative and qualitative data to build clearer understanding of these topics and delivers practical information on potentially helpful learning strategies. This information may assist students with dyslexia navigate learning and assessment activities more efficiently and effectively. This could ultimately contribute to improving university retention and success for this group.

Scholarly research has reported a wide variety of possible strengths and challenges of university students with dyslexia. However, data regarding strengths have been contradictory across studies, making it difficult to reach firm conclusions. Data regarding challenges have been more consistent, but few comparisons exist between students with and without dyslexia. Hence some researchers have suggested university students with dyslexia do not experience greater challenges than other students (Madriaga et al., 2010). Clarification is needed in this area to enable students with dyslexia to harness their strengths and better understand their challenges.

Numerous strategies have also been suggested to improve university experiences and success by students with dyslexia. Some can be implemented by students themselves, some by teaching staff, and others by university accessibility services. Examples of student-directed strategies are concept-mapping and audiobooks (Serry et al., 2018). Teaching and course design strategies include use of diagrams and videos in teaching materials (MacCullagh et al., 2017). Accommodations from accessibility services include provision of text-to-speech software and additional time for examinations (Mortimore & Crozier, 2006). This thesis primarily addresses student-directed learning strategies.

1.1 Defining dyslexia

The International Dyslexia Association (2002) and Australian Dyslexia Association (2018) have defined dyslexia as a specific learning disability of neurobiological origin that affects skills related to reading, such as word-recognition, decoding, and spelling, but does not affect other cognitive abilities. This definition specifically describes developmental dyslexia which affects development of reading skills from childhood. In contrast, acquired dyslexia is caused by brain trauma and affects already established reading skills (Kirby, 2018). Hereafter, the term ‘dyslexia’ will be used to mean ‘developmental dyslexia’.

1.2 Causes and subtypes of dyslexia

Causes of dyslexia are hotly debated (Elliott & Grigorenko, 2014). Key theories include the phonological deficit hypothesis and various visual processing hypotheses. The phonological deficit hypothesis suggests a core cognitive deficit in processing component sounds of words, i.e. ‘phonemes’ (Castles & Friedmann, 2014). Visual processing hypotheses suggest deficits in how visual input is processed by the brain (Stein, 2001; Talcott et al., 2002; Vidyasagar & Pammer, 2010). However, current thinking favours the likelihood of ten or more subtypes of dyslexia, with phonological and visual dyslexia regarded as different subtypes (Friedmann & Coltheart, 2018). This thesis does not investigate causes or subtypes of dyslexia directly. However, it reports data on student self-perceptions of subtypes, and discusses some possible implications of multiple subtypes.

1.3 Prevalence of dyslexia in the general population

Prevalence estimates for dyslexia in the general population vary widely from 4.4% to 11.8% (Flannery et al., 2000; Katusic et al., 2001; Miles, 2004; Shapiro, 1996; Shaywitz et al., 1992). Factors contributing to this wide range of prevalence estimates include variable criteria used to define dyslexia, and different age cut-offs for samples (Elliott & Grigorenko, 2014; Katusic et al., 2001; Miles, 2004).

1.4 Co-existence of dyslexia with other learning differences

Co-existence estimates for dyslexia and other learning differences also vary widely. Agobiani and Scott-Roberts (2015) found 37.4% of a sample of 190 university students with a formal assessment of dyslexia also reported significant characteristics of attention deficit hyperactivity disorder (ADHD) on a self-report screening tool. This is consistent with childhood estimates for co-existence of dyslexia and ADHD, reported by various studies to be from 8.7% to 42.5% (Sexton et al., 2012). Research by Griffin and Pollak (2009) also suggests high co-existence of dyslexia with ADHD and dyspraxia (developmental coordination differences) in adults. Six out of 12 university students with dyslexia in their study also reported ADHD, dyspraxia, or both. Wilson et al. (2015) also reported co-existence of approximately 40% between dyslexia and dyscalculia (developmental numeracy issues). Delineating patterns of co-existence may be beneficial to understanding strength and challenge profiles for university students with multiple learning differences, and strategies that may help them. The current thesis provides co-existence data for the recruited sample. However, the sample size was not sufficient to enable analysis of associations between co-existing differences and other variables.

1.5 Representation of students with dyslexia at university

Currently available Australian data on students in higher education does not include specific information about representation of students with dyslexia. Australian Government data on university participation are currently only reported for students with disabilities overall, not for specific disabilities. It is beyond the scope of the current thesis to discuss the historical and political backdrop to this lack of data specific to students with dyslexia in Australian higher education. Interested readers can find more information on this topic in a separate review by the thesis author (MacCullagh, 2014).

From the data available, it seems likely that some students with dyslexia would have been included in Australian Government statistics about students with disabilities overall. From 2001 to 2016, the proportion of commencing Australian domestic students registering with any disability rose from 8.3% to 15.6% (Australian Government, 2017). The proportion of university students with disabilities completing their degrees were not reported. Due to known high discontinuation rates for university students with disabilities (Sanford et al., 2011), these types of estimates based solely on first-year student intakes are likely to over-represent true inclusion rates across all year levels. Conversely, such estimates may under-represent true inclusion rates if some eligible students did not disclose known disabilities on commencement. Furthermore, some students with dyslexia may commence university without a formal assessment, having compensated through primary and secondary education. Such students would not be included in official government or university statistics.

In the UK, the proportion of university students in their first year of study who had formally disclosed dyslexia increased from 0.7% in 1996-97 to 3.2% in 2004-05 (Mortimore & Crozier, 2006; Warmington et al., 2013). Proportions of students retained into the second and subsequent years of university were not reported. A more recent UK study suggested higher inclusion and disclosure rates, with 7% of students at one university having disclosed dyslexia (Goodwin et al., 2016). These findings suggest that rates of inclusion, disclosure, or both of students with dyslexia in UK universities may be increasing. Similar data are not currently available for Australia.

1.6 University experiences and disclosure of students with dyslexia

Students with dyslexia often describe stressful experiences at university, which may further compound trauma from primary and secondary school (Alexander-Passe, 2016; Madriaga, 2007). They report numerous challenges relating to reading, spelling, speaking, note-taking, organisation, web searching, library database searching, essay writing, written examinations, and practical placements (Berget et al., 2016; Berget & Sandes, 2019; Gibson & Leinster, 2011; Hanafin et al., 2006; MacCullagh et al., 2017; Mortimore & Crozier, 2006; Murphy, 2009; Wiseheart & Altmann, 2018). Students with dyslexia also describe stigma and discrimination around disclosing reading differences and obtaining assistance (Alexander-Passe, 2015; Madriaga, 2007; Pino & Mortari, 2014). These factors can negatively affect wellbeing at university, and contribute to depression, anxiety, isolation, and discontinuation of studies (Alexander-Passe, 2015; Bergey et al., 2017).

Some university students with recognised dyslexia do not disclose their differences to the university or to peers (Alexander-Passe, 2015; Goodwin et al., 2016; Olney & Brockelman, 2003; Ridley, 2011). Non-disclosure can influence university experiences by limiting access to resources from lecturers, university accessibility services, classmates, and friends (Alexander-Passe, 2015; Bergey et al., 2017; Mortimore & Crozier, 2006). Reasons given for non-disclosure and non-registration with accessibility services include negative attitudes of staff or other students, difficulties with registration processes, and requirements for time-consuming and expensive tests (Deuchert et al., 2017; Dobson, 2018; Pirttimaa et al., 2015; Riddell & Weedon, 2006). It is important for students with dyslexia to maintain the right to self-determine all aspects of disclosure or non-disclosure (Madriaga, 2007). However, further exploration of non-disclosure reasons may reveal barriers that could be addressed to enable students to feel confident disclosing differences.

1.7 University retention and success among students with dyslexia

Many students with dyslexia complete university degrees successfully despite associated challenges. However, some differences in academic attainment are evident between dyslexic and non-dyslexic students. UK-based research by Richardson (2015) found similar proportions of students with dyslexia and other specific learning disabilities (SLDs) completed their course modules compared to students with no declared disability (SLD 69.1%; ND 69.0%). Of the students who completed their modules, similar proportions of both groups achieved pass grades or higher (SLD 88.4%; ND 92.8%). However, only 39.8% with SLDs achieved first-class or upper second-class honours, compared to 52.2% of ND peers. A Swedish study by Olofsson et al. (2015) found 52% of students with dyslexia formally assessed (D-A) progressed through their degrees at a

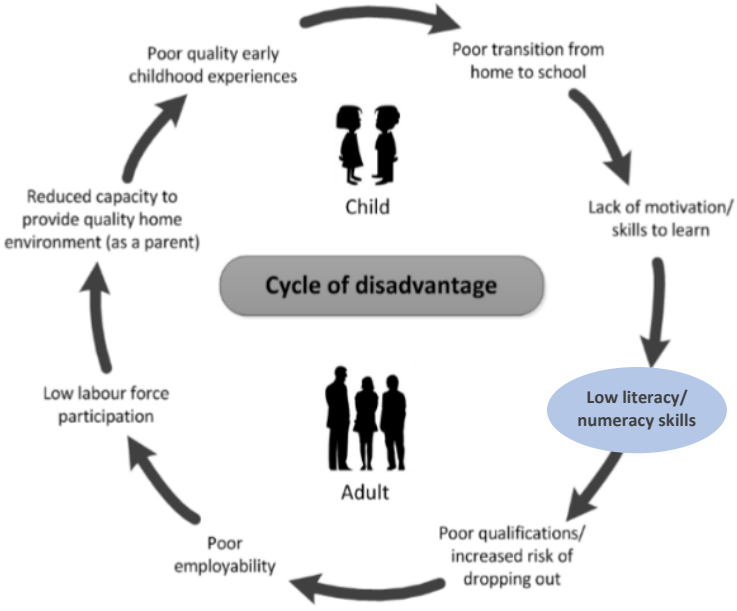
normal pace compared to national averages, but 48% had a low or very low rates of progression and 32% did not complete a degree. Canadian research found first-year students with histories of reading difficulty (HRD) completed fewer subjects successfully and achieved lower grade point averages than peers without HRD (Bergey et al., 2017). Research from the USA found 21% of secondary school students with specific learning disabilities (SLDs) commenced 4-year college degrees within eight years of completing secondary school, compared to 40% with no learning disabilities (NLD) (Cortiella & Horowitz, 2014). Of those who embarked on four-year degrees, 41% with SLDs completed them, compared to 52% with NLD. Considered together, these results suggest that academic success is possible for university students with dyslexia and other learning differences, but disadvantage exists compared to non-dyslexic peers.

1.8 Why university experiences and success are important

Equitable university opportunities for all qualified candidates, including those with dyslexia, is important for social justice, legal compliance, the economy, and community wellbeing.

Most modern societies consider equitable educational opportunity an important human right (Gabel & Connor, 2009). Educational disadvantage can contribute to intergenerational economic disadvantage (McLachlan et al., 2013). This cycle of disadvantage (Figure 1) may be especially relevant to people with dyslexia, due to the known genetic basis of dyslexia, often affecting multiple generations of the same family (Francks et al., 2002). Improving academic success for such students may thus improve economic stability for whole families (Cheng et al., 2016).

Figure 1. Cycle of educational and economic disadvantage (Adapted from: McLachlan et al., 2013)



There are also broader economic benefits to ensuring people with dyslexia have equitable opportunities in higher education. People with dyslexia contribute to the economy in numerous professions, including teaching, nursing, medicine, art, science, engineering, computing, mathematics, and business leadership (Burns & Bell, 2010; Fink, 1998; Gibson & Leinster, 2011; Griffiths, 2012; Logan, 2009; Morgan & Burn, 2000; Schneps, 2010; Wolff & Lundberg, 2002). International data also suggest that functional literacy contributes to economic output. Coulombe et al. (2004) reported that a 1% improvement in national average literacy scores

over the cross-sectional average for the 14 countries surveyed resulted in 2.5% greater labour productivity, and 1.5% greater gross domestic product (GDP) per capita.

Students with dyslexia also represent approximately 4-12% of the potential market for higher education in Australia and internationally. In an increasingly competitive education market, students with dyslexia may be a group that universities cannot afford to ignore. The 'Dyslexia-friendly' quality mark in the UK offers a marketing edge to attract this group (Firth, 2010; Pavey, 2015). International implementation of similar systems could offer economic benefits for universities offering best practice inclusive education.

Inclusive higher education is also important for personal and social wellbeing. Negative experiences at university are linked to anxiety, depression, and poorer life satisfaction for people with dyslexia (Jordan et al., 2014; Kalka & Lockiewicz, 2017; Mugnaini et al., 2009). Low literacy has also been linked to antisocial behaviour and imprisonment (Kirk & Reid, 2001; Moody et al., 2000; Rack, 2005). Some researchers have suggested this pattern may be due to poor literacy instruction, rather than specific learning disabilities (Samuelsson et al., 2003). Both explanations, however, seem to warrant educational responses.

Legal requirements for equity in education have also been increasing globally. In addition to generic anti-discrimination laws, legal rights of students of all abilities to equitable educational inclusion and provision have been strengthened in many countries by regulations or legislation relating specifically to educational contexts. In Australia, the Disability Standards for Education were introduced in 2005, and reviewed in 2015. In the UK, the Special Education Needs and Disability Act (SENDA), was introduced in 2001. In the USA, the Individuals with Disabilities Education Act (IDEA) was enacted in 1990 and strengthened in 2004. These ongoing legal developments offer another motivation to continue improving educational and experiences.

1.9 Approaches to improving university retention and success

Factors suggested to improve retention and success of students with dyslexia at university include transition planning, learning strategies, self-advocacy, social support, and accommodations from accessibility services (Ascherman & Shaftel, 2017; Chevalier et al., 2017; Pitt & Soni, 2017). However, data about relative perceived helpfulness of different approaches does not currently exist. This makes it difficult for students with dyslexia to decide which approaches to use. It also makes it difficult for staff to know how to best advise students, and for policymakers to determine which resources and programs warrant investment.

1.10 Contributions of this study

This study investigates self-reported strengths, challenges, and learning strategies of university students with dyslexia. It offers new quantitative data and comparative analyses between dyslexic and non-dyslexic students that may help determine whether strengths, challenges, or strategies are specific to students with dyslexia or shared by other students. Rankings of overall perceived helpfulness of strategies for dyslexic students only may also be important for prioritising strategies for further research, and for informing implementation choices by university students with dyslexia.

CHAPTER 2: RESEARCH QUESTIONS

This study addresses the following research questions.

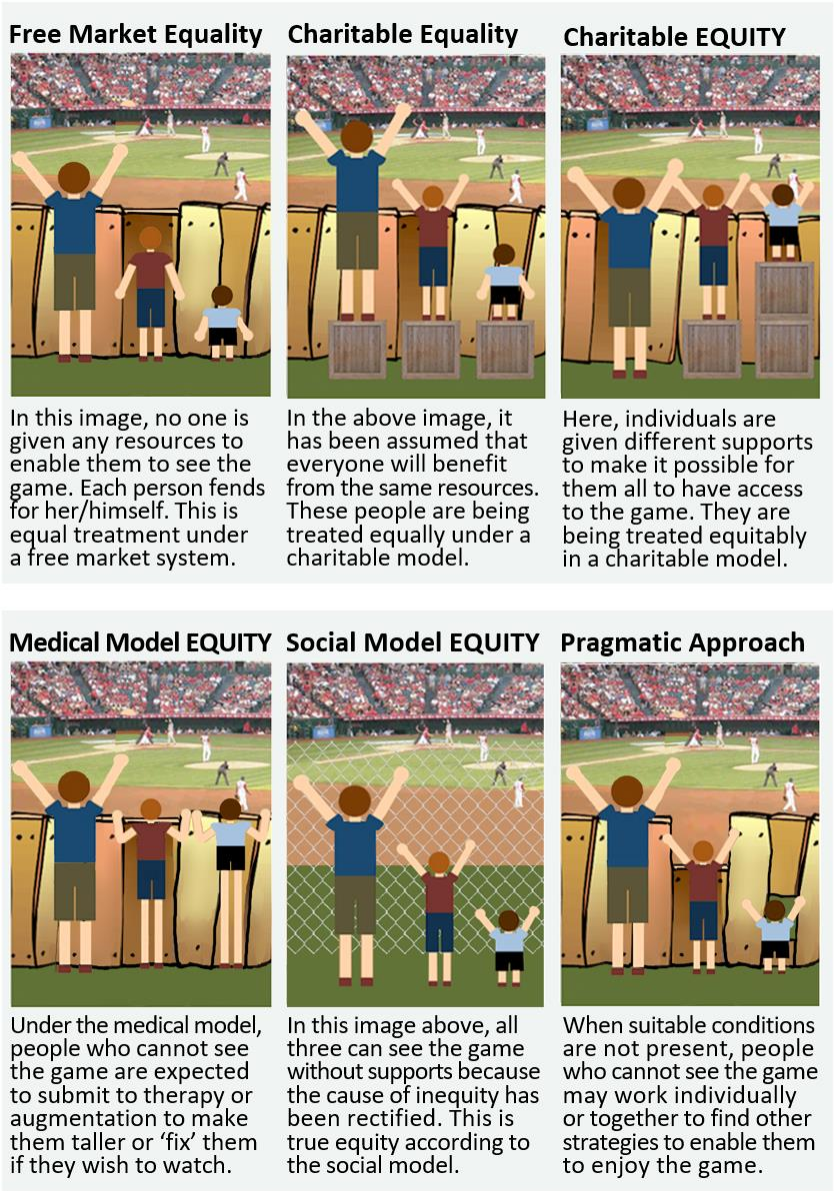
1. What strengths do university students with dyslexia self-identify, and how do these compare to strengths self-identified by non-dyslexic peers?
2. What university activities do students with dyslexia consider difficult, and how do their difficulty ratings compare to those of non-dyslexic peers?
3. What learning strategies do university students with dyslexia perceive as helpful, and do non-dyslexic peers consider the same strategies similarly helpful?

These research questions were guided by two key theoretical and philosophical approaches, namely the social model of disability, and pragmatism. The social model of disability considers disabilities to be socially constructed, caused by non-inclusive societal norms interacting with individual differences (Oliver, 1991). This contrasts with the medical model, which views some individual differences as deficiencies requiring treatment to reach 'healthy' standards (Brisenden, 1986). The social model is guided by principles of equity, empowerment, accessibility, and self-determination. Disability rights activists and academics propose that these principles should be applied to the design of all built spaces, infrastructure, technology, and education, to ensure equitable access for people of all abilities, including those with dyslexia (Charlton, 1998; Oliver, 1991; Riddick, 2001). Pragmatism is a complementary model that encourages researchers to conduct research capable of delivering practical benefits to research populations (Danforth, 2006). Figure 2 illustrates and summarises key features of these models, including some of their subtle variations, based on concepts from the City for All Women Initiative (CAWI, 2015) and Espinoza (2010). While such models do not account for all complexities and experiences of people with dyslexia and other diverse abilities, they nonetheless provide frameworks to build more nuanced conceptualisations and practical responses (Beaudry, 2016; Danforth, 2006; Shakespeare, 2008; Swain & French, 2000).

The overarching topic for this study was chosen partly due to the researcher's first-hand experiences as a university student with dyslexia. This is in keeping with principles of empowerment and self-determination discussed by Charlton (1998). A research project of this type led by a student with dyslexia formally assessed offers an opportunity for sensitive and detailed conceptualisation and discussion of the study topic. Related risk of researcher bias was managed using multiple checks and balances. Firstly, input was received from three expert supervisors with diverse expertise relevant to the study topic: one in higher education, one in dyslexia education across the lifespan, and one in cognitive neuroscience. Secondly, all aspects of study design and implementation were guided by a detailed literature review. Thirdly, robust quantitative analysis methods were used. Finally, the project underwent rigorous review and adjustments by three institutional committees: a research proposal review panel, the human research ethics committee, and an oral presentation feedback panel. In these ways, researcher bias was controlled while the benefits of insider insights were retained.

The decision to focus specifically on behavioural (practical) strategies that students with dyslexia can implement themselves was based on pragmatic considerations. Under the social model, removing socially constructed barriers to educational equity for people with disabilities is considered a shared responsibility between individuals, institutions, society, and governments to (Elkins, 2000; Oliver, 1991). However, institutional, social, and political change can be slow (Elkins, 2000). In the meantime, students with dyslexia may benefit from information about strategies they can use individually to improve their own situations. This choice of research questions does not imply that students with dyslexia have sole responsibility to 'solve' their challenges. Nor does it negate the moral imperative under the social model for universities to provide inclusive learning and assessment approaches. It simply recognises that providing students with dyslexia with information about practical strategies they can use themselves may be a helpful and necessary interim measure while the processes of educational reform continue.

Figure 2. Models of equality, equity, and pragmatism (Adapted from: CAWI, 2015; Espinoza, 2010)



CHAPTER 3: LITERATURE REVIEW

This chapter presents three related narrative reviews, all with systematic elements. The scope of this thesis did not allow for comprehensive systematic literature reviews. However, systematic searches were conducted to inform structured narrative reviews. The following databases searched in August 2019 and June 2020: A+ Education, Australian Education Index, EBSCO Education Research Complete, ERIC, PsycInfo, Medline, and Scopus. Standard search terms for all searches, determined from database subjects, were: [(dyslex* OR reading disab* OR reading impair* OR reading diffic*) in Title/Abstract/Keywords] AND [(universit* OR colleg* OR higher educat* OR tertiar* OR post-secondary) in Title/Abstract/Keywords]. Limits were: English language, and years 2000 to 2020. Inclusion criteria were: original research; recruitment of university students with dyslexia formally assessed (D-A), self-identified (D-S), or histories of reading disability (HRD); and topic relevance.

3.1 Possible academic strengths of university students with dyslexia

Two further search terms to locate papers on possible academic strengths were: (strength* OR advantag*). This delivered 136 papers, of which 17 met inclusion criteria. Table 1 outlines their features and topics.

Table 1. Possible academic strengths of university students with dyslexia

					Possible academic strengths										
First author	**Year**	**Qual/Quant**	**Design**	**Groups (n)**	Deep Learning Approaches	Surface Learning Approaches	Creative Problem Solving	Artistic Creativity	Advanced Vocabulary	Class Participation	Teamwork	Empathy / Insight	Resilience	Determination / Tenacity	Overall Personality Profile
Alexander-Passe	2016	Qual+Quant	Int+Sur	D-A(20) + D-A(101)			●	●			●	●		●	
Cavalli	2016	Quant	Tests	D-A(20); ND(20)					●						
Corkett	2006	Quant	Sur	HRD(29): ND(38)						●					
Griffiths	2012	Qual	Int	D-S(6)			●	●				●			
Kalka	2017	Quant	Tests	D-A(72); ND(80)									●		
Kinder	2012	Quant	Tests	D-A(31); ND(31)		●									
Kirby	2008	Quant	Tests	D-S(36); ND(66)	●										
Mourgues	2014	Quant	Tests	High; Med; Low (Total 259)			●	●							
Murphy	2011	Qual Quant	Int Sur	D-A(10) D-A(14); ND(23)			●								
O'Byrne	2019	Qual	Int	D-A(5)							●		●	●	
Serry	2018	Qual	Sur+Int	D-S(33)										●	
Stack-Cutler	2015a	Quant	Sur	HRD(120)									●		
Swanson	2009	Quant	Meta	D-A(1719); ND(1162)											●
Tops	2013	Quant	Tests	D-A(100); ND(100)											●
Wilson	2013	Qual	Int	D-S(4)									●		
Wiseheart	2018	Quant	Exp	D-A(23); ND(28)					●						
Wolff	2002	Quant	Sur	D-A(12); ND(142)				●							

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; HRD = History of Reading Difficulty; ND = non-dyslexic.
Key to designs: Int = Interview; Sur = Survey; Tests = Standardised tests; Exp = Experiment; Meta = Meta-analysis

This body of research about possible academic strengths of university students with dyslexia is limited and often contradictory. Available findings do not provide clear evidence of the specific nature of the reported potential strengths. They could represent: (1) specific advantages for students with dyslexia compared to non-dyslexic peers, (2) areas of no major difference between groups, (3) perceived strengths of students with dyslexia compared to reading ability, or (4) additional unrecognised challenges for students with dyslexia.

Four potential personality-based strengths, namely 'Teamwork', 'Empathy', 'Resilience' and 'Determination', were predominantly explored in small qualitative studies, and quantitative studies with no comparison groups of non-dyslexic peers (Alexander-Passe, 2016; Griffiths, 2012; Stack-Cutler et al., 2015a; Wilson & Savery, 2013). From such study designs, it is impossible to draw conclusions about how university students with dyslexia compare to non-dyslexic peers on these personality characteristics. Two comparative studies about these potential strengths found university students with dyslexia or histories of reading difficulty may actually score lower on standardised measures of resilience (Kalka & Lockiewicz, 2017) and motivation (Bergey et al., 2017) compared to peers without dyslexia or histories of reading difficulties. Comparative research on overall personality profiles of dyslexic and non-dyslexic university students found no significant differences (Swanson & Hsieh, 2009; Tops et al., 2013). Such inconclusive evidence is inadequate to establish these features as specific advantages of students with dyslexia compared to non-dyslexic peers.

Regarding 'Deep Learning Approaches' and 'Surface Learning Approaches', existence of these constructs has been contested in educational literature (Haggis, 2003; Howie & Bagnall, 2013). Thus, it is not surprising that research findings about their use by university students with and without dyslexia have been mixed. Kirby et al. (2008) reported no significant difference between dyslexic and non-dyslexic participants in standardised test scores for deep or surface approaches to learning. In contrast, Kinder and Elander (2012), reported greater average use of 'Surface Learning Approaches' and lower average use of 'Deep Learning Approaches' by dyslexic learners compared to non-dyslexic peers. From this conflicting evidence, it cannot be concluded that 'Deep Learning Approaches' are a specific strength of students with dyslexia.

'Class Participation' and 'Advanced Vocabulary' have both been identified as potential areas of differential strength for dyslexic students over non-dyslexic peers. Regarding 'Class Participation', Corkett et al. (2006) found a higher proportion of students with histories of reading difficulties (HRD) in post-secondary education reported participating in classroom discussions compared to those with no such histories. For 'Advanced Vocabulary', Cavalli et al. (2016) found that students with dyslexia systematically outperformed non-dyslexic peers on vocabulary depth tasks (relating to accuracy and precision) and equalled them on vocabulary breadth tasks (relating to number of known words). However, Wiseheart and Altmann (2018) found no significant difference between dyslexic and non-dyslexic college students on standardised tests of vocabulary.

'Creative Problem Solving' and 'Artistic Creativity' have both been identified as strengths of people with dyslexia in non-comparative (Alexander-Passe, 2016; Griffiths, 2012) and comparative research (Murphy, 2011; Wolff &

Lundberg, 2002). However, another comparative study found dyslexic college students scored lower than non-dyslexic peers on standardised tests of both types of creativity (Mourgues et al., 2014).

Taken together, the literature on potential academic strengths of university students with dyslexia does not provide clear or consistent evidence of any differential academic advantages over non-dyslexic students. There may be some areas of no difference between dyslexic and non-dyslexic students, such as personality profiles. There could also be areas of strength compared to reading ability, such as class participation, vocabulary skills, and creative problem solving. Counterintuitively, it is also possible that some perceived strengths of university students with dyslexia may in fact be areas of unrecognised disadvantage compared to non-dyslexic peers, such as resilience and deep learning approaches. Overall, however, there are many contradictions and gaps in this body of literature. Thus, firm conclusions are impossible.

3.2 Challenges experienced by university students with dyslexia

A considerable body of research has investigated challenges experienced by university students with dyslexia. These can be divided into three categories: (1) Cognitive and metacognitive challenges; (2) Learning activity challenges; and (3) Assessment challenges. For the purposes of this summary, cognitive and metacognitive challenges have been conceptualised collectively as difficulties with mental skills and abilities that have broad impacts across academic and non-academic tasks. This thesis focusses on challenges with specific learning and assessment activities. Learning activities have been defined as what learners do to meet learning outcomes, while assessment activities are those that provide evidence that learning outcomes have been met (Biggs & Tang, 2011). Research literature on cognitive and metacognitive challenges will first be briefly reviewed, followed by more detailed analysis of studies about learning and assessment activity challenges.

The same databases listed previously were searched again using the standard terms, with the addition of the following terms: AND (challeng* OR difficult* OR disadvantag*). This delivered 738 articles, of which 40 reported results of original research about potential academic challenges encountered by university students with dyslexia. These articles were sorted into categories according to the types of potential challenges they described: (1) cognitive or metacognitive, (2) learning activity, or (3) assessment activity. Those that reported data on multiple types of potential challenges were placed in multiple categories.

3.2.1 Cognitive and metacognitive challenges

Cognitive and metacognitive challenges were explored in 19 of the 40 research articles found in the search on potential challenges experienced at university. From these studies, 12 potential cognitive and metacognitive challenges were identified for university students with dyslexia or histories of reading difficulties. Key features of the articles and the potential challenges they explored are summarised in Table 2. Detailed analysis follows.

Table 2. Cognitive and metacognitive challenges reported by university students with dyslexia

					Academic challenges											
First author	**Year**	**Qual/Quant**	**Design**	**Groups (n)**	Reading speed / fluency	Reading comprehension	Spelling	Writing speed	Spoken sentence production	Arithmetic	Naming	Concentration	Memory	Information processing	Mental fatigue	Academic inconsistency
Alexander-Passe	2016	Qual+Quant	Int+Sur	D-A(20); D-A(101)	●		●	●		●	●	●	●	●		
Ali	2020	Qual	Int	D-A(15)	●	●	●		●						●	
Bergey	2017	Quant	Sur	HRD(244); ND(603)								●		●		
Callens	2012	Quant	Tests	D-A(100); ND(100)	●			●		●			●			
Callens	2014	Quant	Tests	D-A(100); ND(100)	●		●			●	●					
Del Tufo	2020	Quant	Tests	D-A(40); ND(132)							●					
Doikou-Avlidou	2015	Qual	Int	D-A(13)		●	●					●	●			
Gagliano	2015	Quant	Tests	D-A(68); ND(68)	●											
Hebert	2018	Quant	Tests	HRD(23); ND(124)	●	●										
Kalyvioti	2013	Quant	Exp	D-A(7); ND(7)									●			
Lockiewicz	2012	Quant	Tests	D-A(93); ND(87)									●			
Mortimore	2006	Quant	Sur	D-A(62); ND(74)	●		●		●			●	●			
Oga	2012	Qual	Int	D-S(5)	●			●	●	●		●				●
Olofsson	2012	Quant+Qual	Test+Int	D-A(37); D-S(16)			●									
Serry	2018	Qual	Sur+Int	D-S(33)	●	●	●	●	●			●				
Simmons	2000	Quant	Exp	D-A(10); ND(10)		●										
Smith-Spark	2004	Quant	Tests	D-A(26); ND(22)							●	●	●			
Tops	2012	Quant	Exp	D-A(100); ND(100)			●						●			
Wiseheart	2018	Quant	Exp	D-A(23); ND(28)					●				●			

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; HRD = History of Reading Difficulty; ND = non-dyslexic.
Key to designs: Int = Interview; Sur = Survey; Tests = Standardised tests; Exp = Experiment

This body of literature is relatively cohesive, with 10 of the 12 cognitive or metacognitive challenges reported in four or more studies each. Comparative studies of D-A and ND students using standardised tests or experimental designs have been conducted for all listed challenges except mental fatigue and academic inconsistency. Such comparative studies have reported poorer performance by D-A or HRD participants compared to ND peers for all these cognitive and metacognitive skills, except reading comprehension and memory. This strongly suggests that most of these skills could be specific challenges of students with dyslexia.

Students with dyslexia reported reading comprehension as a challenge in three non-comparative studies (Ali et al., 2020; Doikou-Avlidou, 2015; Serry et al., 2018). However, findings of two comparative studies present conflicting findings. One indicated no difference between HRD and ND students on comprehension tests (Hebert et al., 2018). The other found D-A students received similar scores to ND students for literal comprehension questions, but lower for inferential questions (Simmons & Singleton, 2000). From this limited and contradictory evidence, no clear conclusions can be made about whether reading comprehension is a specific challenge for students with dyslexia compared to non-dyslexic peers.

Most studies about memory have indicated specific difficulties for students with dyslexia (Alexander-Passe, 2016; Callens et al., 2012; Doikou-Avlidou, 2015; Lockiewicz et al., 2012; Smith-Spark et al., 2004; Tops et al., 2012; Wiseheart & Altmann, 2018). However, one small study found no significant difference between D-A and ND university students on a virtual reality memory test (Kalyvioti & Mikropoulos, 2013). On the balance, it seems likely that memory issues are a specific challenge for students with dyslexia.

3.2.2 Learning activity challenges

From the literature search for challenges, already described, which revealed 40 research articles about potential challenges at university, 14 articles included information about possible learning activity challenges. These are summarised in Table 3, followed by critical analysis.

Table 3. Learning activity challenges reported by university students with dyslexia

					Learning activity challenges							
First author	**Year**	**Qual/Quant**	**Design**	**Groups (n)**	Note-taking	Following Lecture Slides	General Organisation	Time-management	Navigating E-learning	Searching Library Databases	Web Accessibility	Placement-based Learning
Ali	2020	Qual	Int	D-A(15)	●							
Al-Wabil	2007	Qual	Int	D-A(10)							●	
Berget	2016	Quant	Exp	D-A(20); ND(20)						●		
Berget	2019	Quant	Exp	D-A(20); ND(20)						●		
MacCullagh	2017	Qual	Int	D-S(13); ND(20)	●	●						
Morris	2006	Qual	Int	D-A(18)								●
Mortimore	2006	Quant	Sur	D-A(62); ND(74)	●		●	●				
Murphy	2011	Qual Quant	Int Sur	D-A(10) D-A(14); ND(23)				●				
Olofsson	2012	Quant+Qual	Test+Int	D-A(37); D-S(16)	●						●	
Price	2006	Qual	Int	D-A(10); ND(10)								●
Sanderson-Mann	2012	Qual Quant	Int Sur	D-S(9) D-S(54); ND(52)								●
Serry	2018	Qual	Sur+Int	D-S(33)	●			●				
Wald	2009	Qual	Sur	D-A(54)					●			
White	2007	Qual	Int	D-A(11)								●

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; HRD = History of Reading Difficulty; ND = non-dyslexic.
Key to designs: Int = Interview; Sur = Survey; Exp = Experiment

The articles in Table 3 suggest eight learning activities as specific challenges for university students with dyslexia. However, the strength of evidence varies between challenges. The strongest consensus is for 'Note-taking' and 'Placement-based Learning' being specific challenges for students with dyslexia. Each of these learning activities was identified as a challenge in three or more studies, with at least one study for each being a quantitative comparative study. All other challenges were indicated as specific issues for students with dyslexia

by at least one quantitative comparative study each, except 'Following lecture slides', 'Navigating E-learning', and 'Web Accessibility', which were reported in qualitative non-comparative studies only.

There was also a contradiction evident in this set of articles regarding whether time-management may be a challenge or strength of students with dyslexia. Two studies reported it as a challenge (Mortimore & Crozier, 2006; Murphy, 2011), but one non-comparative study identified it as a positive skill of students with reading difficulties (Serry et al., 2018). Despite this discrepancy and the differing levels of evidence for various challenges, there is broad consensus across most articles reviewed that each learning activity listed is a specific challenge for university students with dyslexia.

3.2.3 Assessment challenges

From the 40 research articles found in the literature search on university challenges, 16 studies explored assessment challenges. These are summarised in Table 4 and analysed subsequently.

Table 4. Assessment challenges reported by university students with dyslexia

					Assessment challenges									
First author	**Year**	**Qual/Quant**	**Design**	**Groups (n)**	Essay Assignments	Class Presentations	Group Assignments	Multiple Choice Exams	Essay Exams	Short-answer Exam Questions	Matching Questions in Exams	Graph Interpretation Questions	Clinical Exams	Inadequate Assessment Options
Ali	2020	Qual	Int	D-A(15)	●									
Carter	2013	Qual	Int	D-A(7); ND(4)	●									
Gibson	2011	Quant	Obs	D-A(91); ND(686)						●	●		●	
Hanafin	2006	Qual	Int	D-A(7)										●
Kim	2014	Quant	Exp	D-A(15); ND(20)								●		
Kim	2017	Quant	Exp	D-A(29); ND(48)								●		
Kinder	2012	Quant	Tests	D-A(31); ND(31)	●									
MacCullagh	2017	Qual	Int	D-S(13); ND(20)		●			●	●				●
MacKay	2019	Quant	Tests	HRD(46); ND(46)	●									
McKendree	2011	Quant	Obs	D-A(36); ND(508)				●		●	●		●	
McPherson	2019	Qual	Int	D-A(3)			●							
Mortimore	2006	Quant	Sur	D-A(62); ND(74)	●				●					
Olofsson	2012	Quant+Qual	Test+Int	D-A(37); D-S(16)	●				●	●				
Pirttimaa	2015	Qual	Int	D-A(10)	●									
Serry	2018	Qual	Sur+Int	D-S(33)	●				●	●				
Tops	2012	Quant	Exp	D-A(100); ND(100)	●				●					

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; HRD = History of Reading Difficulty; ND = non-dyslexic.
Key to designs: Int = Interview; Sur = Survey; Exp = Experiment; Obs = Observations

The studies in Table 4 identified ten potential assessment challenges for university students with dyslexia. However, there are wide variations in strength of evidence for each. The strongest evidence was for essay

assignments and essay exams. Three or more quantitative comparative studies indicate each of these as specific challenges for D-A compared to ND students, as well as multiple qualitative and/or non-comparative studies each. This consensus strongly suggests these may be specific challenges for university students with dyslexia.

Evidence for the other eight potential assessment challenges was weaker. 'Graph Interpretation Questions' were identified as a specific assessment challenge for students with dyslexia by two quantitative comparative studies. 'Class Presentations', 'Group Assignments', and 'Inadequate Assessment Options', were indicated by only one or two qualitative studies each. 'Multiple Choice Exams', 'Matching Questions' and 'Clinical Exams' were investigated by only one or two quantitative comparative studies each, one of which found equivalent performance between D-A and ND students on all three. Finally, while short-answer exams were examined in five studies, the two quantitative comparative studies among these delivered mixed results. One indicated no difference between D-A and ND students in short-answer question performance in first-year or second-year exams (McKendree & Snowling, 2011). The other indicated poorer performance by D-A participants in first year, but equivalent performance in second-year with appropriate accommodations (Gibson & Leinster, 2011). More research is needed to resolve the issues evident in this body of literature.

3.3 Learning strategies used by university students with dyslexia

Research has revealed a wide array of learning strategies used by students with dyslexia at university. These can be broadly categorised as: (1) cognitive or metacognitive; or (2) behavioural (practical). Cognitive and metacognitive strategies are those that address cognitive and metacognitive challenges identified earlier, as well as any other strategies that rely on particular thinking processes. Behavioural strategies are practical techniques that students can directly enact themselves.

The same set of databases described for other literature searches was again searched for studies about learning strategies of university students with dyslexia. The same limits and standard initial search terms were used, with the addition of the following terms: AND (strateg* OR method* OR technique*) AND (student* OR learn* OR study*). This delivered 520 papers, 26 reporting findings of original research relevant to the defined population and topics. These were sorted by the types of strategies they explored: (1) cognitive or metacognitive; and (2) behavioural (practical). Some articles investigated more than one type of strategy and were thus included in both categories.

3.3.1 Cognitive and metacognitive strategies

From the 26 papers about learning strategies, nine studies had investigated potential cognitive and metacognitive strategies. Key features of these articles and the potential strategies explored in them are summarised in Table 5, with critique to follow.

Table 5. Cognitive and metacognitive strategies used by university students with dyslexia

First author	Year	Qual/Quant	Design	Groups (n)	Strategies						
					Spelling Correction Strategies	Self-organisation Strategies	Time-management Strategies	Test-taking Strategies	Selecting Main Ideas	Visual Memory Compensation	Mnemonics
Bacon	2014	Quant	Exp	D-A(35); ND(35)						●	
Bergey	2017	Quant	Tests	HRD(244); ND(603)			●	●	●		
Chevalier	2017	Quant	Tests	HRD(77); ND(295)			●	●	●		
Corkett	2006	Quant	Tests	HRD(29); ND(38)							●
Griffin	2009	Qual	Int	D-A(13)		●					
Kirby	2008	Quant	Tests	D-A(36); ND(66)			●	●	●		
Murphy	2018	Qual	Int	D-A(9)							●
Tops	2014	Quant	Tests	D-A(100); ND(100)	●						
Tops	2019	Quant	Tests	D-A(100); ND(100)			●	●	●		

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; HRD = History of Reading Difficulty; ND = non-dyslexic.
Key to designs: Int = Interview; Sur = Survey; Exp = Experiment

Research findings regarding cognitive and metacognitive strategies have been mixed. Four studies compared HRD or D-A students to ND peers on the Learning and Study Skills Inventory. Of these, three indicated similar use of 'Time-management Strategies' between HRD or D-A students and ND peers, but one (Kirby et al., 2008) found greater use by the D-A group. Three also reported greater use of 'Test-taking Strategies' by HRD or D-A students, but one (Chevalier et al., 2017) did not mention results about 'Test-taking Strategies'. Three studies also found lower scores for HRD or D-A students for 'Selecting Main Ideas', but one (Tops et al., 2019) indicated approximately equivalent scores. Taken together, it seems likely that more D-A and HRD students than ND peers use 'Test-taking Strategies', fewer use 'Selecting Main Ideas', and similar proportions may use 'Time-management Strategies'.

Four individual strategies were investigated by only one or two studies each. These were: 'Spelling Correction Strategies'; 'Visual Memory Compensation'; 'Self-organisation Strategies'; and 'Mnemonics'. From this limited evidence, it is difficult to determine the nature of these four potential strategies.

3.3.2 Behavioural (practical) learning strategies

From the 26 research articles found about university learning strategies, 21 studies had explored behavioural (practical) strategies that students could implement themselves. From these articles, more than 30 such strategies were identified. These are summarised in Table 6, followed by detailed critique.

Table 6. Behavioural (practical) learning strategies used by university students with dyslexia

					Behavioural (practical) learning strategies																																
First author	**Year**	**Qual/Quant**	**Design**	**Groups (n)**	Print slides before lectures	Sit in a specific spot in classes	Special note-taking techniques	Attend or view lectures multiple times	Make personal lecture recordings	Pause and replay lecture recordings	Attend multiple tutorial groups	Rewrite notes with pictures or diagrams	Concept maps or essay plan diagrams	Social strategies (friends, family, etc.)	Self-testing	Read strategically	Read on mobile device	Adjust text into narrow columns	Highlight, underline, or circle	Specific font	Reduce screen glare	Increase or decrease light levels	Creative use of technology	Coloured paper	Coloured background on screens	Coloured overlays	Find videos online instead of reading	Audiobooks	C-pen or other text scanner	Screen reading software (self-sourced)	Read out loud	Soft music while reading	Quiet space while reading	Low background noise	Spell checker in MS Word or similar	Separate spell checker (self-sourced)	Separate grammar checker (self-sourced)
Andreassen	2017	Quant	Diary	D-A(17); ND(17)								●		●					●									●		●							
Bergey	2017	Quant	Tests	HRD(244); ND(603)											●																						
Chevalier	2017	Quant	Tests	HRD(77); ND(295)											●																						
Corkett	2006	Quant	Tests	HRD(29); ND(38)								●	●		●																						
Crouch	2019	Qual	Int	D-A(12)																						●											
Griffin	2009	Qual	Int	D-A(13)									●						●																		
Kalka	2017	Quant	Tests	D-A(72); ND(80)										●																							
Leadbeater	2013	Quant	Obs	D-S(8); ND(131)						●																											
MacCullagh	2017	Qual	Int	D-S(13); ND(20)	●	●	●	●	●	●	●	●				●			●	●	●	●		●			●				●	●				
Moojen	2020	Quant	Tests	D-A(28; ND(28)										●																							
O'Byrne	2019	Qual	Int	D-A(5)	●														●												●						
Olofsson	2012	Quant+Qual	Test+Int	D-A(37); D-S(16)	●					●		●		●					●									●									
Pirttimaa	2015	Qual	Int	D-A(10)	●			●											●														●	●	●	●	
Pitt	2017	Qual	Int	D-A(5)										●																							
Pollak	2002	Qual	Int	D-A(33)			●			●			●																	●			●				
Price	2016	Qual	Int+Log	D-A(3)									●						●				●		●	●			●	●					●	●
Schmitt	2012	Quant	Exp	D-A(3)																									●							
Schneps	2010	Quant	Exp	D-A(8); ND(8)													●	●																		
Serry	2018	Qual	Sur+Int	D-S(33)						●			●															●								
Sjoblom	2016	Quant	Exp	D-A(24); ND(24)																						●										
Stack-Cutler	2015b	Quant	Sur	HRD(120)										●																						

Key to groups: D-A = Dyslexic, formally assessed; D-S = Dyslexic, self-identified; ND = non-dyslexic. **Key to designs:** Diary = Daily diary; Int = Interview; Sur = Survey; Exp = experiment; Log = Writing log

The literature regarding behavioural (practical) learning strategies of university students with dyslexia contains very few quantitative studies comparing perceived helpfulness of individual strategies for D-A and ND students. Much research in this area has been qualitative interview-based studies of students with dyslexia or HRD only. These studies have produced lists of strategies that these students report using, but quantitative comparative evidence is limited. The quantitative studies that are available have explored use of study aids as a broad category of strategies, without delineating usage rates or helpfulness of individual strategies.

Of the 33 behavioural learning strategies identified in previous research literature, 11 were investigated using quantitative comparative methods for possible differences in usage rates or benefits between D-A or HRD students and ND peers. These eleven were: 'Pause and replay lecture recordings'; 'Rewrite notes with pictures or diagrams'; 'Concept maps or essay plan diagrams'; 'Social strategies (friends, family, etc.)'; 'Self-testing'; 'Read on mobile device'; 'Adjust text into narrow columns'; 'Highlight, underline, or circle'; 'Coloured overlays'; 'Audiobooks'; and 'Screen reading software (self-sourced)'. However, there was poor consistency between study findings for each of these strategies. Only 'Pause and replay lecture recordings' and 'Audiobooks' were found to be differentially beneficial to D-A, D-S, or HRD students compared to ND peers in all quantitative comparative studies that investigated them. From this evidence, it is difficult to conclude whether any of these strategies are likely to be more helpful to students with dyslexia than non-dyslexic peers.

Four studies investigated overall use of study aids, without specifying individual strategies. Three used the Learning and Study Skills Inventory to rate participants' overall use of study aids, finding approximately equivalent scores for D-A or HRD participants and ND peers (Bergey et al., 2017; Chevalier et al., 2017; Tops et al., 2019). One used a custom questionnaire, which indicated greater overall use of study aids by D-A than ND participants (Corkett et al., 2006). Furthermore, one of those studies indicated test scores were not associated with academic performance (Bergey et al., 2017), and one found scores for use of study aids predicted academic success (Chevalier et al., 2017). The collective results of these four studies suggest that use of study aids overall probably does not differ significantly between dyslexic and non-dyslexic students. However, usage rates for individual learning strategies were not compared.

Based on available literature, it is difficult to delineate which of the 33 listed behavioural (practical) learning strategies are used differentially by students with dyslexia and are perceived by this group as more helpful than other strategies. To date, no study has compared usage rates or helpfulness ratings between D-A and ND students for this set of strategies using the same measurement scales for each strategy. Nor has any study compared perceived helpfulness between strategies for dyslexic students.

A broad comparative study of learning strategies would be beneficial. Further comparisons are needed between dyslexic and non-dyslexic groups, and between strategies for dyslexic students. Such information may be useful to researchers choosing topics for further studies, and to students with dyslexia selecting learning strategies.

CHAPTER 4: METHODS

This study was an online, mixed-methods survey for students with and without dyslexia from Australian universities. An online survey was chosen for participant convenience and efficient data collection within the timeframe permitted for a Master of Research. A mixed-methods design was chosen to build on prior exploratory qualitative research in this area (MacCullagh et al., 2017). Mixed-methods research is appropriate when both confirmatory (quantitative) and additional exploratory (qualitative) data are required to answer the research questions (Johnson & Christensen, 2016). Predominantly quantitative data were collected in this study, to tentatively confirm, refute and build on patterns and explanations from previous qualitative research. Qualitative data were also collected to identify whether any important variables or patterns had been missed by previous studies, and to provide additional insights regarding quantitative findings.

4.1 Recruitment

In October 2019, survey information and links were distributed via multiple methods: (1) The electronic system for the Macquarie University linguistics students' research participation; (2) An email sent to the Macquarie University Accessibility Service for distribution to all students registered with dyslexia; (3) Posters displayed on notice boards around Macquarie University Campus; and (4) Social media, including the Macquarie University Student Facebook group, adult dyslexia Facebook groups, Twitter and LinkedIn.

4.2 Research instrument

The online survey included sections on each of the following topics: (1) demographic information, such as age, gender, and language background; (2) learning history and assessments, including dyslexia, dyscalculia, dyspraxia, attention deficit hyperactivity disorder (ADHD), and autism spectrum; (3) reading experiences, such as perceived speed, accuracy, and enjoyment, (4) sensory experiences; (5) spelling experiences; and (6) educational experiences, including attainment, university strengths, university challenges, and learning strategies used at university. The strengths, challenges and learning strategies included in the survey were based on constructs revealed in the preceding literature review. Appendices 1 and 2 contain the full survey questions.

The survey was designed in accordance with the principles outlined by De Cesarei and Baldaro (2015) for designing surveys for university students with disabilities. Accessibility features included text-to-speech narration, and use of question formats with good accessibility such as radio buttons. It was built using the REDCap survey tool (Vanderbilt University, n.d.), due to the available accessibility features, question formats, and security features. The most important accessibility feature for the target population was text-to-speech narration, which was available in REDCap, but not in other survey options such as Qualtrics. A critical question format for this study was continuous slider-based rating scales with numeric values (0–100) and descriptive text labels for each end and the centre point, also available in REDCap but not Qualtrics. REDCap also offered robust data security, with all data stored on local servers at the host institution, in this case, Macquarie University, Sydney, Australia.

Two versions of the survey were developed: one for students with reading difficulties, and one for those without reading difficulties. This was done to control recruitment into the different groups. Participants meeting the criteria for dyslexia formally assessed (D-A) and dyslexia self-identified (D-S) were determined from responses to the version for students with reading difficulties. Differences between the two versions of the survey were minimal. Phrasing of some questions was adjusted for relevance to each group. Questions that were not relevant to non-dyslexic students, such as those relating to university disclosure, were also removed from the version for students without reading difficulties. Differences between versions are detailed in Appendix 2.

Prior to release, user testing was conducted to improve survey navigation and clarity. The version for students with reading difficulties was tested by three adults with formally assessed dyslexia. The version for people without reading difficulties was tested by six adults without a formal assessment of dyslexia or any suspicion of reading difficulties. Feedback from user testing was used to correct survey functionality, adjust question order, and improve wording for greater clarity.

The recruitment strategy and survey construction were guided by a combination of the social model and pragmatism. A medical model approach of directly conducting formal diagnostic assessments on all research participants was rejected, mainly for logistical reasons. A social model approach which may have allowed participants to self-select into 'dyslexic' and 'non-dyslexic' groups, was also rejected due to the pragmatic need to ensure construct validity, i.e. the reasonable certainty that participants in the dyslexic group are in fact dyslexic (Johnson & Christensen, 2016). Instead, a hybrid approach was used, whereby volunteers self-selected whether to complete either a survey labelled 'for students WITH reading difficulties', or equivalent 'for students WITHOUT reading difficulties'. Then, by their responses to questions within the surveys, formal assessment status was determined and used to allocate participants to groups for analysis.

Survey questions were based on literature regarding characteristics and experiences of university students with dyslexia, outlined in the literature review, especially Table 6. However, due to the broad range of characteristics and experiences reported in this literature, not all could be included. Constructs were excluded that could not be easily explained to participants in an online survey. For example, four behavioural learning strategies were excluded because they could each be understood in multiple ways and would require lengthy explanations to clarify: reading strategically (MacCullagh et al., 2017); creative use of technology (Price, 2016); self-testing (Bergey et al., 2017; Chevalier et al., 2017; Corkett et al., 2006); and social strategies (Andreassen et al., 2017; Kalka & Lockiewicz, 2017; Olofsson et al., 2012; Pitt & Soni, 2017; Stack-Cutler et al., 2015b).

The survey collected both quantitative and qualitative data. All quantitative survey questions required forced-choice responses. For example, data on proportions of participants using various learning strategies were collected using radio buttons rather than requiring participants to type their responses. This was done to optimise the completeness and integrity of the quantitative data. Qualitative data were collected using

optional free-text response boxes for participants to add information about forced-choice responses or explain when they had selected 'Other' from a drop-down list.

The survey took approximately 35-45 minutes for participants to complete, plus 5-15 minutes to read the participant information and consent forms (60 minutes total). This duration enabled collection of sufficient data to answer the research questions, while limiting risk of fatigue. Potential fatigue was also managed by placing tips at regular intervals throughout the survey, such as: 'Stand up and stretch before continuing'.

4.3 Data quality consideration

During data collection, an unexpected issue was detected relating to fraudulent gift-voucher claims. Some survey respondents completed the survey only once but used the separate gift voucher claim form to claim multiple gift vouchers. This issue was managed in consultation with Macquarie University's human research ethics team who deemed it appropriate to exclude these survey responses from the dataset and withhold related gift vouchers. The rationale behind this decision was that people making fraudulent gift voucher claims may not have entered authentic responses into the survey. One of the excluded respondents sent an email enquiry about the gift voucher. This person was sent a gift voucher, but the associated survey response remained excluded from the dataset. This approach carries a risk that a small number of valid survey responses may have been excluded from the dataset, or that a small number of fraudulent responses may have been included. The risk of excluding a small number of valid responses was deemed acceptable by the human research ethics committee, and the risk of including fraudulent responses was mitigated by screening the remaining data to ensure responses were authentic.

4.4 Participants

A total of 148 complete and valid survey responses were received from October to November 2019. Of these, 70 were from students who indicated having dyslexia formally assessed (D-A) by an appropriately qualified professional such as a psychologist or speech pathologist, 20 with self-identified dyslexia (D-S), and 58 with no assessment for dyslexia, nor self-belief of dyslexia, who were thus categorised non-dyslexic (ND).

4.4.1 Selection criteria

All participants indicated via screening questions at the start of the survey that they met the selection criteria: (1) age 18 years or older; (2) enrolment at an Australian university any time from 2015 to 2019; (3) English was best spoken and written language; and (4) no hearing or uncorrected vision impairment.

Age 18 years or older was used as a primary selection criterion to include most university students, and to streamline ethical approval by limiting the sample to adults who could provide self-consent. Current or recent enrolment at an Australian university was chosen as a selection criterion because this aligned with the location of the researcher, and a population with whom limited prior research had been conducted (Maccullagh, 2014; MacCullagh et al., 2017). To minimise potential survivorship bias, participation was not limited to current university students, but rather, allowed participation by anyone who had studied at an

Australian university any time in the preceding five years. If only currently-enrolled students were included, potential insights would have been missed from students who experienced difficulties at university and either deferred or discontinued. The final two criteria, relating to English language proficiency and known sensory impairments, were used because these may be confounding variables that cause reading or educational difficulties unrelated to dyslexia.

4.4.2 Target sample size and actual numbers recruited

The goal was to recruit 40 students with dyslexia formally assessed (D-A), 40 with dyslexia self-identified (D-S), and 40 non-dyslexic peers (ND). However, more students than expected were recruited to the D-A group (n = 70). To obtain a comparable sample size for the ND group, additional participants were recruited to the version of the survey for students without reading difficulties until all gift vouchers were used (n = 58). The target of 40 D-S students was not achieved, with only 20 participants meeting inclusion criteria for this group. Additional participants for this group could not be easily recruited, as they were a subset of those who completed the version of the survey for students with reading difficulties. D-S participants (n = 20) were excluded from analyses due to the small sample size.

4.4.3 Gender distribution

The D-A group included 32 females (45.7%) and 38 males (54.3%), while the ND group had 19 females (32.8%), 38 males (65.5%) and one person of non-binary gender (1.7%). Pearson 2x2 Chi-Square test for independence between gender and group did not find a statistically significant association, $\chi^2(1) = 2.00$, $p = 0.203$.

4.4.4 Age at time of survey

Average age in the D-A group was 22.67 years (SD = 3.40 years; range 18-39 years), and in the ND group was 21.81 years (SD = 3.63 years; range 18-36 years). An independent-samples *t*-test on average age between the two groups did not indicate this difference to be statistically significant, $t(126) = 1.38$, $p = 0.169$.

4.4.5 Age when formally assessed with dyslexia

Of the 70 participants in the D-A group, 35 (50%) indicated they had been formally assessed as being dyslexic at age 6-10 years, four at 2-5 years, 20 at 11-15 years, seven at 16-20 years, and five when aged 21-35 years.

4.4.6 Participant self-identification of dyslexia subtypes

Participants in the D-A group were asked if they had been told a dyslexia subtype in their formal assessment, and if so, which one. Response options were based on the list of ten subtypes of developmental dyslexia published by Friedmann and Coltheart (2018). Participants could only select one option each. From 70 D-A participants, 17 selected attentional dyslexia, 13 selected letter identity dyslexia, 10 visual dyslexia, seven letter position dyslexia, seven neglect dyslexia, six phonological dyslexia, three surface dyslexia, one vowel letter dyslexia, one deep dyslexia, and none indicated access to semantics dyslexia. Three participants could not recall a subtype and two indicated they had not been told a subtype.

4.4.7 Formal assessment of co-existing learning differences

In the D-A group, 35 participants (50%) indicated they had been formally assessed with one or more other learning differences. Of these, 18 had been assessed with dyscalculia, 14 dyspraxia, 15 attention deficit hyperactivity disorder (ADHD), and one with autism. In the ND group, no participant indicated having been assessed with another learning difference. High co-existence rates of dyslexia with dyscalculia, dyspraxia, and ADHD are consistent with other academic literature on this topic (Agobiani & Scott-Roberts, 2015; Sexton et al., 2012; Wilson et al., 2015). However, absence of any students in the ND group reporting other learning differences is unexpected as prevalence estimates in the general population are 1-10% for each difference surveyed (Hansen et al., 2015; Kirby & Drew, 2013; Polanczyk et al., 2014; Szűcs & Goswami, 2013).

4.4.8 Disclosure of dyslexia during university enrolment

As part of university enrolment, students are generally asked about disabilities. Of the 70 students in the D-A group, 36 (51.4%) reported disclosing dyslexia during enrolment, 33 (47.1%) indicated not disclosing, and one was unsure (1.4%). It is difficult to know whether these low disclosure rates are characteristic of the whole population of university students with dyslexia, as published research on this topic has been limited. However, if these rates do reflect population behaviour, then research study designs based on auditing official institutional records or recruiting from institutional databases may miss a subset of students with dyslexia who attend university but do not disclose their difficulties to the university.

Among the 33 D-A students who had not disclosed, their reasons are presented in Table 7 in descending order from most to least common. Participants were able to select multiple reasons. Two students who indicated 'Other' stated their reasons as: 'did not know I had a reading difficulty' and 'I didn't know you could get help from the university if you told them'.

Table 7. Non-disclosure reasons of D-A participants who had not disclosed (n = 33)

	Count
Concern about potential discrimination	18
Didn't want different treatment	16
Lack of perceived benefit	8
Other	2

Strong responses for discrimination concern and not wanting different treatment are consistent with published research about issues of stigma and fear of discrimination among university students with dyslexia (Alexander-Passe, 2015; Madriaga, 2007).

4.4.9 Registration with accessibility service by students with dyslexia

After enrolment, students with dyslexia can usually also register with a university accessibility service to receive accommodations. Among the 70 students of D-A group, 43 (61%) indicated they had registered with accessibility services at their universities, and 27 (39%) had not. This low registration rate is consistent with

Australian and international findings of limited accessibility service uptake by university students with dyslexia (MacCullagh et al., 2017; Mortimore & Crozier, 2006; Olofsson et al., 2012; Serry et al., 2018).

The 27 students (38.6%) who had not registered cited the reasons laid out in Table 8. The one student who indicated 'Other', stated the reason: 'I do not think I need them'.

Table 8. Non-registration reasons of D-A participants who had not registered for services (n = 27)

	Count
Lack of perceived benefit	14
Time-consuming assessments required	14
long wait times for assessments	11
expense of assessments	7
insufficient time to register	2
Did not want services	1
Other	1
Waiting period for accessibility consultation	0

Indication of 'Lack of perceived benefit' as a key reason for not registering with the accessibility service is consistent with previous research that has suggested services available may be poorly suited to the needs of students with dyslexia (MacCullagh et al., 2017). Non-registration reasons relating to required assessments are also consistent with known data regarding long duration, long wait times, and high costs of assessments (Burke, 2004; Weeks, 2015). These patterns are especially concerning in the context of only two participants indicating they did not want or need services. This suggests considerable unmet needs.

4.5 Procedure

Volunteers for this survey followed a hyperlink, where they could either read or listen to the participant information and provide informed consent using tick-boxes before continuing to the survey questions. Participants were able to discontinue the survey at any time by closing the browser window. If they returned later using the same device, they could resume where they left off. Those who completed the survey were given the option to receive either course credit or a $15 electronic gift voucher in appreciation for their time. They were also asked if they wish to be sent a summary of the survey results, and/or receive more information about strategies described in the survey.

4.6 Data analysis

Quantitative data analysis commenced with descriptive statistics, followed by inferential statistics to explore statistical significance of between-group differences. Inferential analysis involved overall models for sets of variables and individual follow-up calculations for specific variables. All quantitative analyses were conducted using SPSS for Windows, Version 26. A summary of the key statistical analyses, and the research questions they address, is provided in Table 9.

Table 9. Research questions and statistical analyses used to address them

Research questions	**Descriptive statistics**	**Inferential statistics**
1. Self-reported strengths	Proportions reporting various strengths	Comparison of proportions of D-A vs. ND groups reporting each (GEE models and Chi-Squares)
2. Self-reported challenges	Average difficulty ratings for various activities	Comparison of average difficulty ratings by D-A vs. ND groups (ANOVAs and t-tests)
3. Perceived helpfulness of learning strategies	Proportions using various learning strategy Average helpfulness ratings for various strategies Overall perceived helpfulness rankings of strategies for D-A participants, based on combining usage proportions and average helpfulness ratings	Comparison of proportions of D-A vs. ND groups using each (GEE models and Chi-Squares) Comparison of average helpfulness ratings by D-A vs. ND groups (t-tests)

Two types of inferential statistical models were used, as appropriate to the type of data being analysed: Generalised estimating equations (GEEs) or analysis of variance (ANOVA). GEE models were used for binary quantitative data such as proportions of participants either 'identifying' or 'not identifying' various strengths, and proportions 'using' or 'not using' various strategies. GEEs were ideal for this application because they enable both group and repeated measures comparisons with binary data (Lipsitz et al., 1994). For each GEE model, an unstructured working correlation matrix was specified with robust standard error estimation. Follow-up analyses of group differences in individual binary variables used Pearson Chi-Square calculations.

Mixed ANOVA models were used to analyse continuous quantitative data on difficulty of common learning and assessment activities. These were followed by individual t-tests for between-group differences for each activity. ANOVA models could not be used to analyse continuous data for average helpfulness ratings due to the different numbers of participants providing ratings for each strategy. However, t-tests were performed on these data using $p < 0.01$ as the standard for statistical significance.

For statistical analyses involving many individual comparisons, such as multiple Chi-Squares or repeated t-tests, a significance level of $p < 0.01$ was used to control Type I error rate inflation (i.e. risk of false positive results from repeating an analysis multiple times). With overall models such as GEEs and ANOVAS, Type I error is controlled by the models, so significance was determined at $p < 0.05$.

Qualitative responses were limited, so thematic analysis was not considered appropriate. Instead, qualitative data are presented in full where available, and discussed in relation to quantitative findings.

4.7 Ethical aspects of the study design

Ethics approval for this study was received from the Human Sciences Subcommittee of the Macquarie University Human Research Ethics Committee, approval number 52019578110468 (Appendix 3). Key ethical considerations were confidentiality, survey accessibility, potential distress, and appropriate remuneration.

4.7.1 Ensuring confidentiality

Confidentiality is critical for human research, especially with participants who may be vulnerable to discrimination. Confidentiality requirements for human research have been outlined in the *National Statement on Ethical Conduct of Human Research*, developed jointly by the National Health and Medical Research Council and Universities Australia (NHMRC & UA, 2018). Specific confidentiality requirements for conducting online surveys with students with disabilities have also been outlined by De Cesarei and Balardo (2015). To ensure confidentiality, the only identifying data collected from participants was an email address or student number to administer remuneration or send information requested. These were collected in a REDCap data form separate from the main survey, exported separately, and stored in a different CloudStor folder to the main study data. REDCap and CloudStor both use secure data storage in Australia, so Australian privacy and data management laws apply (AARNet, 2019; Vanderbilt University, n.d.). Files containing potentially identifying data will be destroyed after the minimum storage duration of five years (NHMRC & UA, 2019). No potentially identifying information will be included in any publication of findings.

4.7.2 Maximising survey accessibility

Key accessibility features used in the survey were text-to-speech narration, and survey distribution by multiple methods including social media. Optimal accessibility of the survey for the target population was considered important to satisfy the ethical principles of fairness and respect for research participants, from the *National Statement* (NHMRC & UA, 2018). Good accessibility was also necessary for obtaining a sample with a broad range of participants from the target population (De Cesarei & Baldaro, 2015).

4.7.3 Minimising potential distress

To mitigate potential distress, contact details for the Chief Investigator, ethics office, and counselling services were provided at the start and end of the survey. This is in line with principles of respect and considering the needs of potentially vulnerable participants, as per the *National Statement* (NHMRC & UA, 2018).

4.7.4 Appropriate remuneration

Remuneration decisions were guided by the principles of 'respect for research participants', 'fairness in the treatment of others', and 'giving appropriate consideration to the needs of minority groups or vulnerable people', from the *National Statement* (NHMRC & UA, 2018). Remuneration was considered adequate to show respect for participants' time, but not be so much to influence people to participate if they did not wish to. Participants were offered the choice of receiving either a $15 gift voucher or course credits for one hour of their time. The gift voucher amount was higher than the rate of $10 per hour offered to participants in many research participation pools, but lower than the Australian minimum wage of $19.50 per hour.

CHAPTER 5: RESULTS

Each section of this analysis begins with descriptive statistics, followed by inferential statistics to determine statistical significance of patterns in the data. Where available, qualitative data are presented in full.

5.1 Perceived strengths at university

Participants indicated perceived strengths at university by selecting one or more of the following options: 'Deep Learning', 'Active Learning', 'Resilience', 'Creative Problem Solving', 'Teamwork', 'Class Participation', and 'Other'. Participants who selected 'other' could type additional perceived strengths.

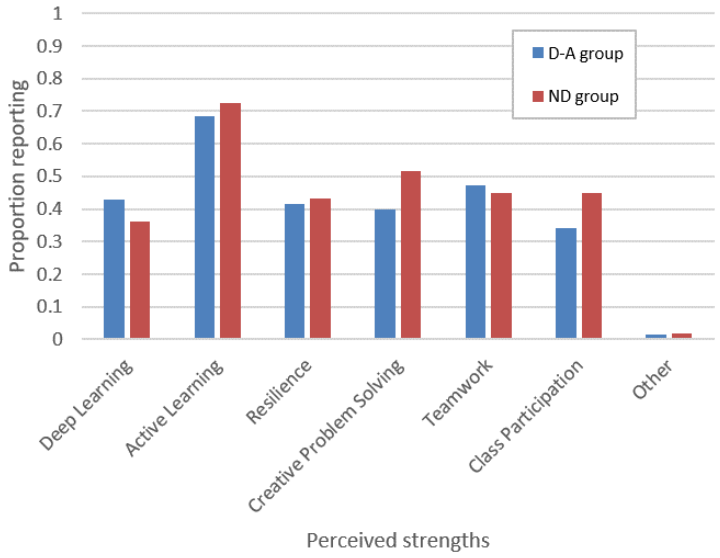
5.1.1 Average number of perceived strengths reported per student

The average number of perceived strengths selected by students in the D-A group was 2.75, standard error of the mean (SEM) = 0.15, range = 1-6. The average number for the ND group was 2.95, SEM = 0.18, range = 1-6. An independent-samples t-test did not find a statistically significant difference between groups in average total perceived strengths, t(126) = -0.819, p = 0.404.

5.1.2 Proportions of D-A and ND groups reporting each strength

Figure 3 shows that most strengths were reported by roughly 34-52% of participants from each group, except 'Active Learning', which was indicated by approximately 70% of each group.

Figure 3. Proportions in D-A and ND groups reporting each strength



A generalised estimating equation (GEE) was constructed on binary strength data (1 = present, 0 = absent), with group and strength as predictor variables. The model did not indicate a significant main effect of group when averaged across all strengths, $\chi^2(1) = 0.665$, $p = 0.415$. However, it did indicate a significant main effect of strength, $\chi^2(5) = 39.311$, $p < 0.001$, indicating that when averaged across groups, one or more strengths were reported by a significantly greater proportion of participants than others, likely 'Active Learning'. No significant interaction effect between group and strength was found, $\chi^2(5) = 3.584$, $p = 0.611$, meaning group belonging did not influence strengths reported.

Follow-up Chi-Square analyses did not indicate any statistically significant differences at the $p < 0.01$ level between proportions of D-A and ND participants reporting any strength. For deep learning, $\chi^2(1) = 0.585$, $p = 0.444$; active learning, $\chi^2(1) = 0.224$, $p = 0.636$; resilience, $\chi^2(1) = 0.036$, $p = 0.849$; creative problem solving, $\chi^2(1) = 1.759$, $p = 0.185$; teamwork, $\chi^2(1) = 0.068$, $p = 0.794$; and class participation, $\chi^2(1) = 1.481$, $p = 0.224$.

One participant in each group indicated an 'Other' strength. The participant from the D-A group stated this as: "Anything that involved being creative such as presentations. Instead of doing powerpoints like most other students, I enjoy finding a way to complete the task in fun, inventive ways." The participant from the ND group indicated the strength of: "visual learning and practical hands on learning".

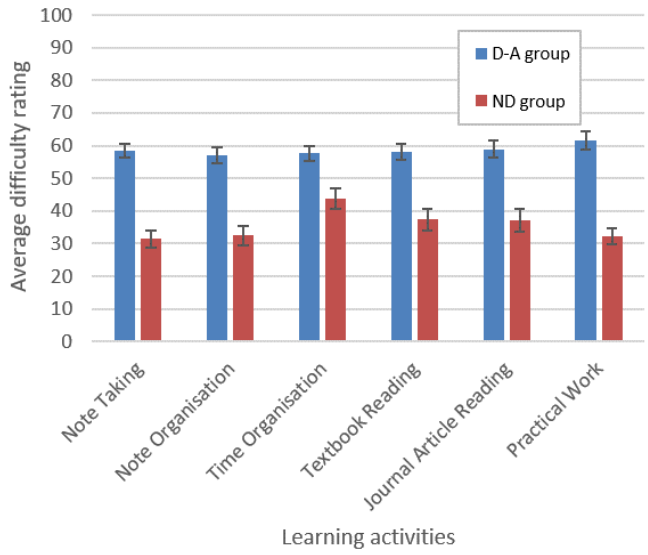
5.2 Perceived challenges at university

Participants then rated the difficulty of various learning and assessment activities on continuous slider scales from 0 to 100, with 0 labelled 'Very easy', 50 labelled 'Neutral' and 100 labelled 'Very difficult'.

5.2.1 Learning activity challenges

Figure 4 shows descriptively higher average difficulty ratings for the D-A group than the ND group for all learning activities surveyed. Average ratings for the D-A group all fall between approximately 57 and 62, and all SEM bars overlap. For the ND group, all average ratings are between 32 and 44, with most but not all SEM bars overlapping. No SEM bars for the D-A group overlap with any SEM bars for the ND group.

Figure 4. Average difficulty ratings for learning activities by the D-A and ND groups



A mixed ANOVA model was constructed for average reported difficulty of learning activities, with group as a between-subjects factor, and activity as a within-subjects factor. The sphericity assumption was violated, Mauchly's Test, $\chi^2(14) = 61.144$, $p < 0.001$, so a Huynh-Feldt adjustment was applied to the analysis.

A statistically significant main effect of group was observed, $F(1,126) = 74.479$, $p < 0.001$, indicating that when averaged across activities, the D-A group rated this set of learning activities as significantly more difficult than the ND group. No statistically significant main effect of activity was found, $F(4.408,555.452) = 2.090$, $p = 0.074$.

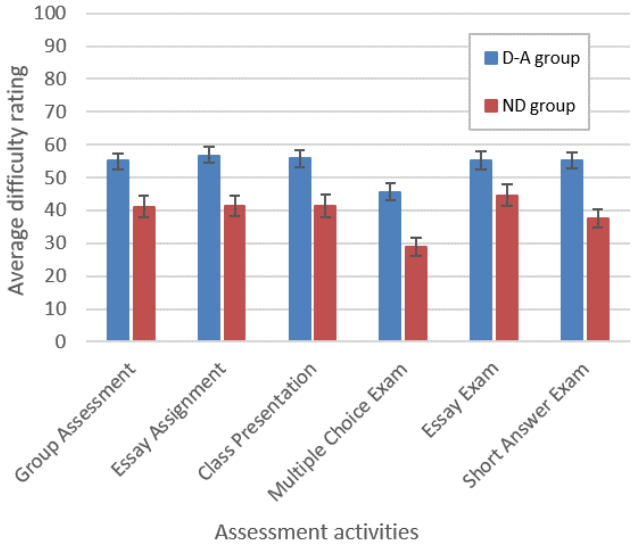
A statistically significant overall interaction effect was observed, $F(4.408,555.452) = 3.155$, $p = 0.011$, indicating the differences between groups were not equal across the different activities.

Individual t-tests indicated the differences in average difficulty ratings by the D-A and ND groups were statistically significant for every learning activity. For note-taking, $t(126) = 8.246$, $p < 0.001$; note organisation, $t(126) = 6.406$, $p < 0.001$; time organisation, $t(107.721) = 3.518$, $p = 0.001$; textbook reading, $t(126) = 5.095$, $p < 0.001$; journal article reading, $t(108.187) = 4.912$, $p < 0.001$; and practical work, $t(126) = 7.985$, $p < 0.001$.

5.2.2 Assessment challenges

Average difficulty ratings for assessment activities (Figure 5) were descriptively higher for the D-A group than the ND group for every assessment activity. For the D-A group, average difficulty ratings are approximately 55 to 57 for most assessment activities, except 'Multiple Choice Exam', which was rated approximately 46. SEM bars for most activities also overlapped, except 'Multiple Choice Exam' which was rated less difficult. For the ND group, average ratings range from 37 to 45, except 'Multiple choice Exam' which was rated approximately 29. Most SEM bars for the ND group also overlap, except for 'Multiple Choice Exam'.

Figure 5. Average difficulty ratings for assessment activities by D-A and ND groups



A mixed ANOVA was used to examine these data, with group as a between-subjects factor and assessment activity as a within-subjects factor. The sphericity assumption was not met, Mauchly's Test, $\chi^2(14) = 43.377$, $p < 0.001$, so a Huynh-Feldt adjustment was applied.

A statistically significant main effect of group was observed, $F(1,126) = 33.407$, $p < 0.001$, indicating the D-A group rated these assessment activities significantly more difficult on average than the ND group. A significant main effect of assessment activity was also observed, $F(4.643,585.066) = 7.869$, $p < 0.001$, likely reflecting the lower average difficulty ratings by both groups for multiple choice exams. The interaction effect between group and activity was also significant, $F(4.643,585.066) = 0.524$, $p = 0.745$.

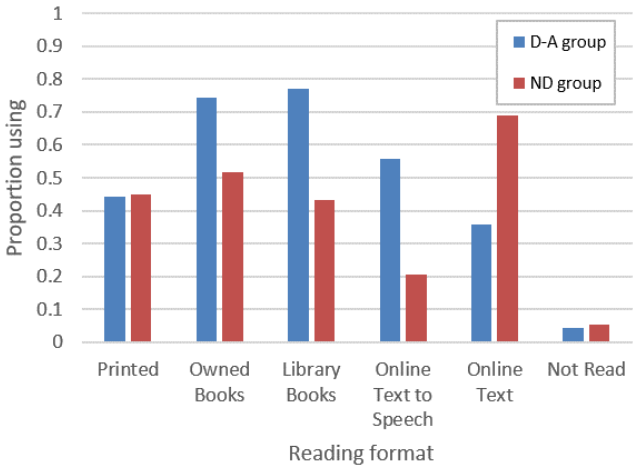
Follow-up t-tests indicated statistically significantly higher difficulty ratings for the D-A group compared to the ND group for all assessment activities except essay exams. For group assessments, $t(95.293) = 3.671$, $p < 0.001$; essay assignments, $t(126) = 3.587$, $p < 0.001$; class presentations, $t(103.902) = 3.340$, $p = 0.001$; multiple choice exams, $t(126) = 4.144$, $p < 0.001$; essay exams, $t(109.217) = 2.542$, $p = 0.012$; and short answer exams, $t(126) = 4.940$, $p < 0.001$.

5.3 Reading formats used at university

Participants selected formats they used for university readings from these options: 'Printed on paper', 'In books that I own', 'In books from the library', 'Online with text-to-speech software', 'Online without text-to-speech software', 'I don't read them', and 'Other (please specify below)'. One participant in the D-A group selected 'Other' and commented: '[I] get the information through podcasts or audiobooks'. No participants from the ND group selected 'Other'.

Figure 6 shows descriptively higher proportions of D-A than ND participants reported using 'Owned Books' (D-A 74%; ND 52%), 'Library Books' (D-A 77%; ND 43%) and 'Online Text-to-Speech' (D-A 56%; ND 21%). A lower proportion of D-A than ND participants used 'Online Text' (D-A 36%; ND 69%). Roughly equal proportions of both groups reported using 'Printed Readings' (D-A 44%; ND 45%) and 'Not Read' (D-A 4%; ND 5%).

Figure 6. Proportions of students in D-A and ND groups using various reading formats



A GEE model with group and reading format as predictors for usage (used vs. not used) indicated statistically significant main effects for group, $\chi^2(1) = 4.521$, $p = 0.033$, and reading format, $\chi^2(5) = 62.388$, $p < 0.001$. The interaction between group and reading format, $\chi^2(5) = 39.559$, $p < 0.001$, was also significant.

Follow-up Chi-Square tests of independence found statistically significantly greater proportions of the D-A than ND group used books they owned, $\chi^2(1) = 7.013$, $p = 0.008$, library books, $\chi^2(1) = 15.555$, $p < 0.001$, and online readings with text-to-speech software, $\chi^2(1) = 16.234$, $p < 0.001$. A statistically significantly smaller proportion of the D-A group used online readings without text-to-speech software, $\chi^2(1) = 14.031$, $p < 0.001$. Statistically significant differences were not found in proportions of the D-A and ND groups using printed readings, $\chi^2(1) = 0.004$, $p = 0.951$, or not doing readings, $\chi^2(1) = 0.056$, $p = 0.813$.

5.4 Learning strategies used at university

A set of 35 student-directed learning strategies were selected for analysis of usage and perceived helpfulness by D-A and ND participants. All surveyed strategies are presented in Table 10.

Table 10. Learning strategies surveyed in the order presented, organised into six categories

Categories	Strategies
Class strategies (related to lectures & tutorials)	Printing slides before lectures Sitting in a specific spot in lecture theatres Attending or viewing lectures multiple times Frequently pausing and replaying lecture videos Attending more than one tutorial group for the same subject Re-writing lecture notes in pictures and diagrams
Visual Layout	Using a particular font Reading on a mobile phone Adjusting text into narrow columns Using a ruler or finger to keep your place on the page Beeline reader or other app to help track from line to line on screen Highlighting or underlining key words or phrases Circling or boxing key words or phrases
Visual Environment	Reducing screen glare Reducing screen contrast Increasing light levels Decreasing light levels Printing on coloured paper Coloured background on screens Using coloured overlays Wearing coloured glasses or contact lenses
Reading Substitution	Watching videos instead of reading Audio books (other than Daisy books) C-pen or other text scanner Screen reader software you found or bought yourself
Auditory	Reading aloud to yourself Listening to soft music while reading Listening to loud music while reading Reading in a quiet place Reading in a place with low background noise Reading in a place with high background noise
Spelling and Grammar	Spell checker built-in to Microsoft Word or similar Grammar checker built-in to Microsoft Word or similar Separate spell checking software Separate grammar checking software

It should be noted that when participants completed the survey questions about these learning strategies, they had already answered questions about accessibility service accommodations in a previous section. They were

instructed to only indicate using the learning strategies presented here if they had done so independently of their university's accessibility service.

5.4.1 Average total number of learning strategies used per participant

From learning strategies surveyed, participants in the D-A group used an average of 18.72 strategies per participant (SD = 6.569). In the ND group, the average was 17.60 strategies (SD = 4.859). An independent samples t-test did not find a statistically significant difference in the average number of strategies used per participant between groups, t(124.498) = 1.112, p = 0.268.

5.4.2 Overview of proportions of D-A and ND groups using each strategy

Participants indicated whether they had used each learning strategy by selecting from the following response options: 'Yes', 'No but would like to try it', and 'No and don't want to try it'. For analysis, these were reduced to binary categories 'Used' or 'Not used'. Table 11 presents data on proportions of participants from the D-A and ND groups who indicated that they had used each of these learning strategies.

Table 11. Proportions of D-A and ND groups reporting use of each learning strategy

Strategy	**D-A**	**ND**
Pre-printing Slides	57.1%	50%
Specific Location	61.4%	48.3%
Lecture Reattendance	47.1%	55.2%
Pause and Rewind	42.9%	72.4%
Multiple Tutorials	40%	19%
Diagram and Picture	52.9%	53.4%
Specific Font	8.6%	41.4%
Reading on Phone	75.7%	53.4%
Narrow Columns	62.3%	39.7%
Object Placeholder	54.3%	60.4%
Line Tracker Software	41.4%	15.5%
Highlight and Underline	68.6%	84.5%
Circling	51.4%	70.7%
Reducing Glare	74.3%	81%
Reducing Contrast	82.9%	60.3%
Increasing Light	74.3%	75.9%
Decreasing Light	74.3%	81%
Print coloured Paper	60%	19%

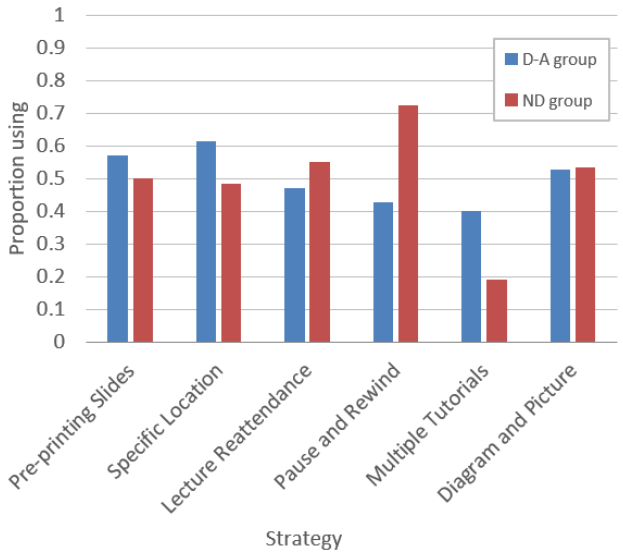
Strategy	**D-A**	**ND**
Coloured Background	60%	31%
Coloured Overlays	41.4%	22.4%
Coloured Glasses	32.9%	10.3%
Video Substitution	60%	75.9%
Audiobooks	68.6%	36.2%
Text Scanner Personal	58.6%	19%
Screen Reader Personal	54.3%	25.9%
Reading Aloud	57.1%	77.6%
Soft Music	64.3%	63.8%
Loud Music	20%	29.3%
Quiet Space	75.7%	94.8%
Low Background Noise	55.7%	82.8%
High Background Noise	20%	20.7%
Packaged Spell Checker	61.4%	79.3%
Packaged Grammar Check	58.6%	69%
Separate Spell Checker	24.3%	15.5%
Separate Grammar Check	30%	25.9%

Qualitative comments about strategy usage indicated very few additional strategies, suggesting that the set of strategies surveyed was reasonably comprehensive. The small number of additions offered should be considered when designing further research on this topic.

5.4.3 'Class' strategies usage comparisons

For 'Class' strategies (Figure 7), descriptive analysis suggested higher proportions of participants from the D-A group compared to the ND group using 'Pre-printing Slides', 'Specific Location' and 'Multiple Tutorials'. Lower proportions of the D-A group appear to use 'Lecture Reattendance', and 'Pause and Rewind'. Similar proportions of both groups seem to use 'Diagram and Picture'.

Figure 7. Proportions of D-A and ND groups using 'Class' strategies



A GEE model constructed for 'Class' strategies indicated that the main effect of group was not statistically significant, $\chi^2(1) = 0.071$, $p = 0.790$. However, a statistically significant main effect of strategy was observed, $\chi^2(5) = 27.417$, $p < 0.001$. A significant interaction effect was also found between group and strategy, $\chi^2(5) = 19.760$, $p = 0.001$, indicating the strategy effect was dependent on group.

Follow-up Chi-Square analyses for group differences indicated a statistically significantly greater proportion of the D-A group than the ND group reporting using 'Multiple Tutorials', $\chi^2(1) = 6.624$, $p = 0.010$, and a statistically significantly smaller proportion of the D-A group reporting using 'Pause and Rewind', $\chi^2(1) = 11.260$, $p = 0.001$. Differences in usage proportions between the D-A and ND groups were not found to be statistically significant for the following: 'Pre-printing Slides', $\chi^2(1) = 0.651$, $p = 0.420$; 'Specific Location', $\chi^2(1) = 2.221$, $p = 0.136$; 'Lecture Reattendance', $\chi^2(1) = 0.818$, $p = 0.366$; or 'Diagram and Picture', $\chi^2(1) = 0.004$, $p = 0.947$.

Five D-A participants and four ND participants indicated using additional 'Class' strategies. Those indicated by the D-A participants were:

> "Taking notes prior to the lecture then listing to the lecture after going to the physical lecture a day after"
>
> "Highlighting with different coloured highlighters"
>
> "Talking to my tutors"
>
> "Mind mapping"

"I write myself little practise questions on each lecture to make sure that I understand all of the things I have learnt".

Additional 'Class' strategies described by ND participants were:

"Re-writing and sampling notes multiple times"

"To learn the content from lectures/ tutorials I usually get a friend to go back and forth and test questions on the content. This helps me to consolidate the content and quizzes me to think on the spot without referring to my notes. I try to do this with most of my exams."

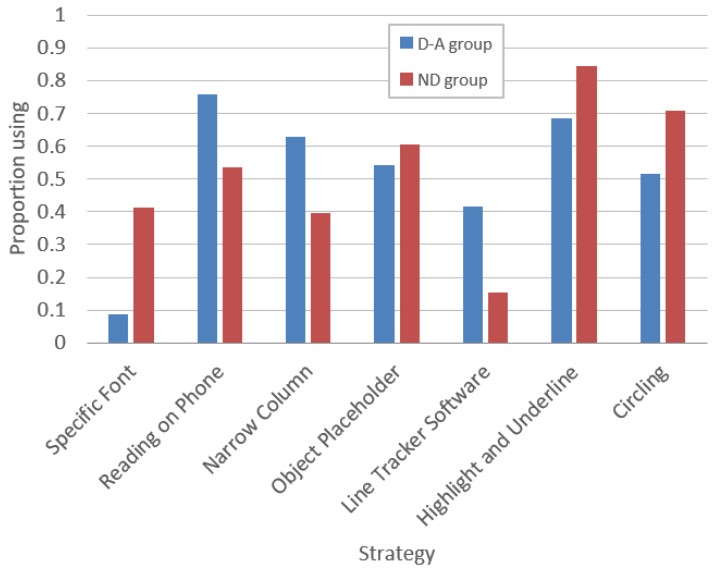
"Taking notes on specific things the lecturer says"

"Not taking notes during lecture to avoid distraction or missing points, then note taking when listening to recordings of the same lecture at home".

5.4.4 'Visual Layout' strategies usage comparisons

For 'Visual Layout' strategies (Figure 8) a wide variety of usage proportions can be seen across strategies and between groups. Descriptively lower proportions of D-A than ND participants appear to have used 'Specific Font', 'Object Placeholder', 'Highlight and Underline', and 'Circling'. Higher proportions of D-A than ND participants appear to have used 'Reading on Phone', 'Narrow Column', and 'Line Tracker Software'.

Figure 8. Proportions of D-A and ND groups using 'Visual Layout' strategies



The GEE constructed for this data indicated no significant main effect of group, $\chi^2(1) = 0.338$, $p = 0.561$. However, a statistically significant main effect of strategy was found, $\chi^2(6) = 158.565$, $p < 0.001$, and a significant interaction effect between group and strategy was also observed, $\chi^2(6) = 32.107$, $p < 0.001$, showing the strategy effect was dependent on group.

Follow-up Chi-Square analyses indicated three strategies had been used by significantly greater proportions of the D-A group than the ND group: 'Reading on Phone', $\chi^2(1) = 6.971$, $p = 0.008$; 'Narrow Columns', $\chi^2(1) = 6.845$, $p = 0.009$; and 'Line Tracker Software', $\chi^2(1) = 10.202$, $p = 0.001$. One strategy had been used by a significantly smaller proportion of the D-A group: 'Specific Font', $\chi^2(1) = 19.026$, $p < 0.001$. Differences in usage proportions between groups were not statistically significant for other strategies: 'Object placeholder', $\chi^2(1) = 0.475$, $p = 0.491$; 'Highlight and Underline', $\chi^2(1) = 4.375$, $p = 0.036$; or 'Circling', $\chi^2(1) = 4.909$, $p = 0.027$.

Qualitative data were collected about font preferences and use of additional 'Visual Layout' strategies. Fonts preferred by D-A participants who had used a 'Specific Font' were: Arial (x1), Calibri (x2), Dyslexia font (x1), and Roman Times 2 (x1). Fonts listed by ND participants were: 'Arial' (x6), Calibri (x2), Comic Sans (x1), Garamond (x1), Nunito Light (x1), and 'Times New Roman' (x11). One participant in each group also specified font size: 'Calibri 11 or 12' from a D-A participant and 'Calibri size 12 or 14' from an ND participant.

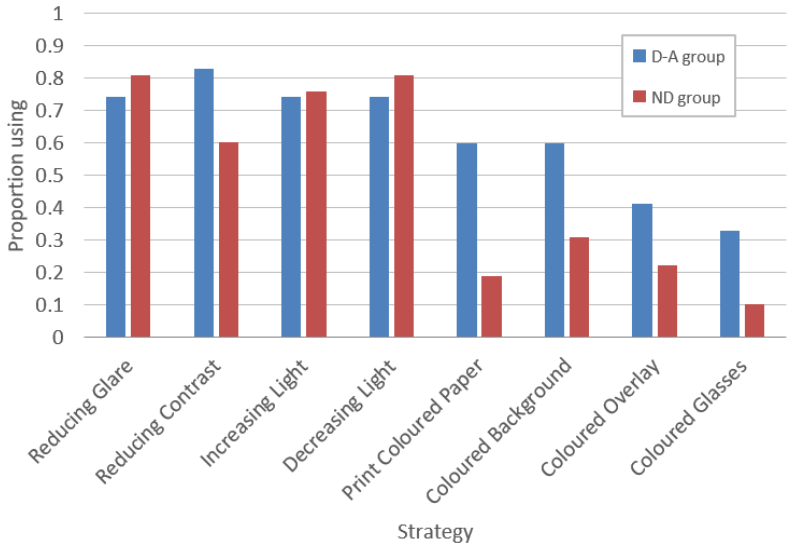
Two D-A participants indicated using additional 'Visual Layout' strategies. No ND participants reported using any further strategies in this category. The additional strategies stated by D-A participants were:

> "Using multiple colours for each paragraph"
>
> "I use different coloured pens to organise my notes".

5.4.5 'Visual Environment' strategies usage comparisons

For the 'Visual Environment' category (Figure 9), descriptive analysis suggests roughly similar proportions of participants from D-A and ND groups had used 'Reducing Glare', 'Increasing Light' and 'Decreasing Light'. All other strategies in this category were used by larger proportions of D-A participants than ND participants.

Figure 9. Proportions of D-A and ND groups using 'Visual Environment' strategies



The GEE model for 'Visual Environment' strategies indicated statistically significant main effects of group, $\chi^2(1) = 11.735$, $p = 0.001$, and strategy, $\chi^2(7) = 156.164$, $p < 0.001$. There was also a significant interaction effect, $\chi^2(7) = 31.920$, $p < 0.001$, meaning differences between groups are unequal across strategies.

Follow-up Chi-Square tests indicated statistically significantly greater proportions of the D-A group than the ND group had used: 'Reducing Contrast', $\chi^2(1) = 8.091$, $p = 0.004$; 'Coloured Paper', $\chi^2(1) = 22.014$, $p < 0.001$; 'Coloured Background', $\chi^2(1) = 10.687$, $p = 0.001$; and 'Coloured Glasses', $\chi^2(1) = 9.174$, $p = 0.002$. Differences between groups in usage proportions were not found to be statistically significant for 'Reducing Glare', $\chi^2(1) = 0.824$, $p = 0.364$, or 'Coloured Overlay', $\chi^2(1) = 5.202$, $p = 0.023$.

One D-A participant and two ND participants reported using additional 'Visual Environment' strategies. The comment from the D-A student about additional strategies in this category was:

> "Having a bigger font and putting it on a bigger screen so that I can read it a bit easier".

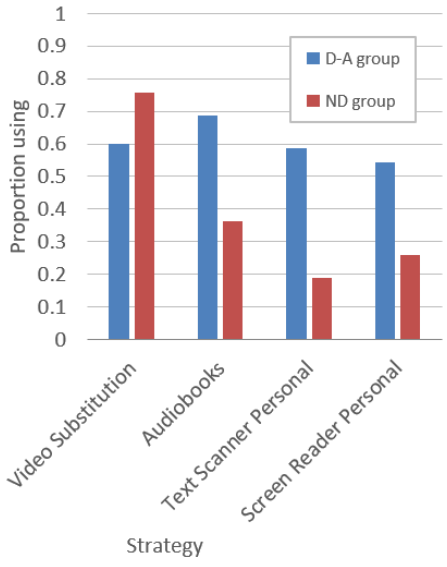
Comments from the two ND students were:

> "Reading/studying is so much easier in the library rather than outside due to the glare factor and distractions"
>
> "Taking adequate breaks to avoid eye fatigue or strain".

5.4.6 'Reading Substitution' strategies usage comparisons

For the 'Reading Substitution' strategies surveyed (Figure 10), a descriptively smaller proportion of the D-A group reported using 'Video Substitution' compared to the ND group. The other three strategies in this category were all reported by larger proportions of the D-A group than the ND group.

Figure 10. Proportions of D-A and ND groups using 'Substitution' strategies



The GEE for 'Reading Substitution' strategies indicated statistically significant main effects for group, $\chi^2(1) = 13.060$, $p < 0.001$, and strategy, $\chi^2(3) = 27.169$, $p < 0.001$. There was also a significant interaction effect, $\chi^2(3) = 27.893$, $p < 0.001$, showing the group and strategy effects were interdependent.

Chi-Square tests of independence were used to examine simple between-group effects. The test for 'Video Substitution' did not find sufficient evidence of a statistically significant difference between proportions of

the D-A and ND groups reporting using this strategy, $\chi^2(1) = 3.620$, $p = 0.057$. The other three simple effects were all significant, indicating greater proportions of the D-A group than the ND group reported having used the following: 'Audiobooks', $\chi^2(1) = 13.371$, $p < 0.001$; 'Text Scanner Personal', $\chi^2(1) = 20.627$, $p < 0.001$; and 'Screen Reader Personal', $\chi^2(1) = 10.562$, $p = 0.001$.

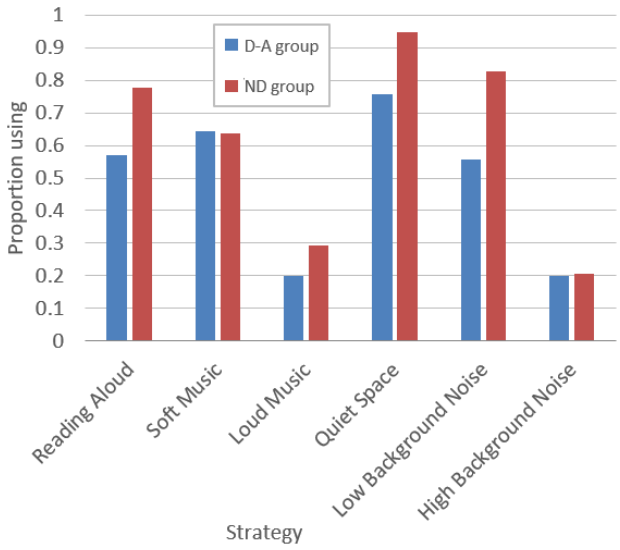
Two D-A participants reported using additional 'Reading Substitution' strategies. No ND participants reported using additional strategies in this category. The comments of the D-A participants were:

> "I ask people to give me a break down of what the reading was about. If I do need to read I try to break it down in smaller amounts"
>
> "Often I find summaries of books/ papers online. So instead of actually reading the paper, I read the summary and then decide if it is worth me reading the whole paper. If I do read certain papers, it is often for the purpose of finding references and things to quote so I will click "control, f" on my keyboard to search for certain phrases."

5.4.7 'Auditory' strategies usage comparisons

For 'Auditory' strategies (Figure 11), descriptively lower proportions of D-A than ND participants reported using 'Reading Aloud', 'Loud Music', 'Quiet Space', and 'Low Background Noise'. Similar proportions from both groups reported using 'Soft Music', and 'High Background Noise'.

Figure 11. Proportions of D-A and ND groups using 'Auditory' strategies



The GEE model for 'Auditory' strategies indicated a statistically significant main effect of group, $\chi^2(1) = 10.788$, $p = 0.001$, with significantly lower proportions of D-A participants using these strategies relative to ND participants, when averaged across all strategies. A statistically significant main effect of strategy was also observed, $\chi^2(5) = 109.283$, $p < 0.001$, and a statistically significant interaction effect between group and strategy, $\chi^2(5) = 11.128$, $p = 0.049$.

Follow-up Chi-Square analyses for group differences showed statistically significantly lower proportions of the D-A group than the ND group used: 'Quiet Space', $\chi^2(1) = 8.789$, $p = 0.003$; and 'Low Background Noise', $\chi^2(1) = 10.656$, $p = 0.001$. Statistically significant differences in usage proportions between groups were not found for: 'Reading Aloud', $\chi^2(1) = 5.942$, $p = 0.015$; 'Soft Music', $\chi^2(1) = 0.003$, $p = 0.954$; 'Loud Music', $\chi^2(1) = 1.498$, $p = 0.221$; or 'High Background Noise', $\chi^2(1) = 0.009$, $p = 0.923$.

Three D-A participants and two ND participants indicated using additional 'Auditory' strategies. The additional strategies described by the D-A participants were:

> "Recording what I have read and then listen to it with headphones on."
>
> "Be quiet"
>
> "Put noise cancelling headphones with no background noise".

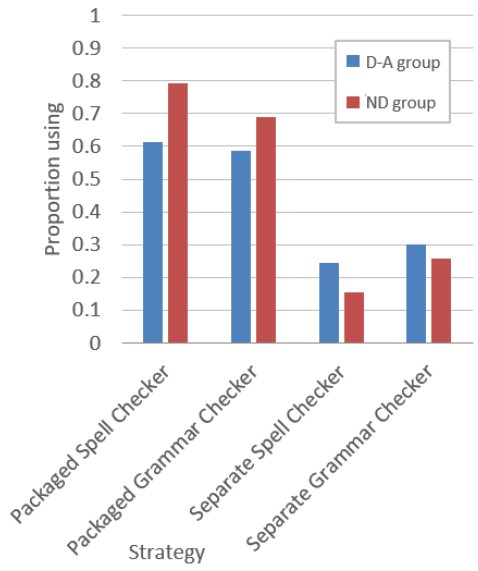
Additional strategies indicated by the two ND participants were:

> "Putting headphones on, with no music or audio. Just blocks out noise, and also shows people around you that are not to be disturbed."
>
> "[Avoid] loud noises and distractions … stay in quiet areas to read".

5.4.8 'Spelling and Grammar' strategies usage comparisons

For 'Spelling and Grammar' strategies (Figure 12), 'Packaged Spell Checker' and 'Packaged Grammar Checker' were used by descriptively greater proportions of ND than D-A participants. Conversely, 'Separate Spell Checker' and 'Separate Grammar Checker' were each used by slightly higher proportions of the D-A group than the ND group.

Figure 12. Proportions of D-A and ND groups using 'Spelling and Grammar' strategies



A GEE model for 'Spelling and Grammar' strategies did not demonstrate a statistically significant main effect for group, $\chi^2(1) = 0.369$, $p = 0.549$. It did indicate a statistically significant main effect of strategy, $\chi^2(3) = 79.568$, $p < 0.001$. There was no significant interaction effect between group and strategy, $\chi^2(3) = 6.809$, $p = 0.078$.

Follow-up Chi-Square analyses for group effects did not find sufficient evidence for statistically significant differences in proportions of D-A and ND participants using any of these strategies: 'Packaged Spell Checker', $\chi^2(1) = 4.787$, $p = 0.029$; 'Packaged Grammar Checker', $\chi^2(1) = 1.475$, $p = 0.225$; 'Separate Spell Checker', $\chi^2(1) = 1.507$, $p = 0.229$; 'Separate Grammar Checker', $\chi^2(1) = 0.269$, $p = 0.604$.

Three participants from each group commented on additional 'Spelling and Grammar' strategies. The three D-A participants indicated using the following strategies:

> "Online spellcheck and cite me"
>
> "Proofreader"
>
> "Have people proofread my work".

The three ND participants described similar additional 'Spelling and Grammar' strategies:

> "I use Grammarly"
>
> "After writing, take a break and then re-read"
>
> "Independent proof reading".

5.5 Perceived helpfulness of learning strategies used

Participants also indicated perceived helpfulness of learning strategies with quantitative ratings and qualitative comments. Helpfulness ratings were indicated on slider scales from zero to 100, labelled at three points: zero was labelled 'Not at all helpful', 50 'Somewhat helpful', and 100 'Very helpful'. Optional comments were collected using free-text response fields for each category of learning strategies.

5.5.1 Overview of average helpfulness ratings by D-A and ND groups for each strategy

Average helpfulness ratings by the D-A and ND groups for all learning strategies surveyed are presented in Table 12. Average ratings for all strategies fall between 60 and 76 across both groups. It should be noted that numbers of responses varied between strategies as participants only rated helpfulness of strategies they had reported using. It is also noteworthy that helpfulness ratings were not collected for 'Increasing Light' or 'Decreasing Light' due to the highly situational nature of needing to use these strategies.

Results of t-tests did not reveal any statistically significant differences between groups in average helpfulness ratings for any strategy at the $p < 0.01$ level. Full details of these non-significant results are provided in Appendix 4. The following analysis also highlights key patterns from the qualitative data. A complete list of all qualitative comments is available in Appendix 5.

Table 12. Average helpfulness ratings for learning strategies by D-A and ND groups

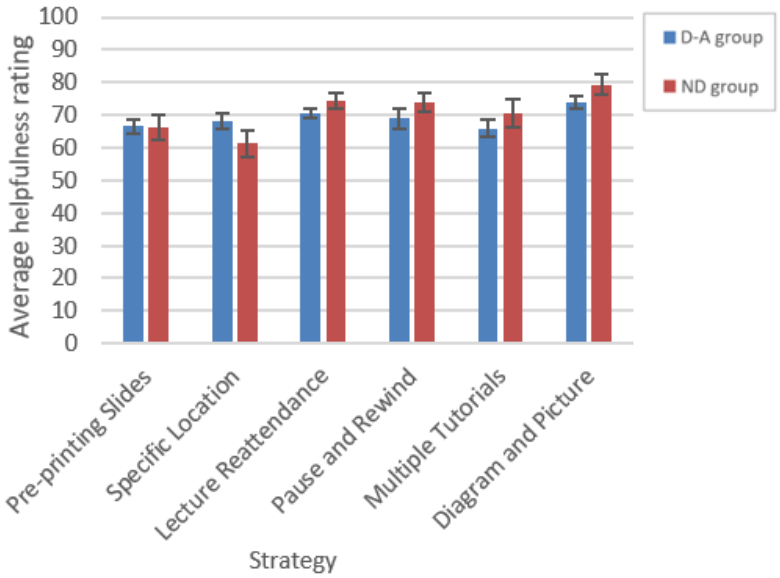
Strategy	D-A	ND
Pre-printing Slides	66.5	66.2
Specific Location	68.1	61.3
Lecture Reattendance	70.6	74.4
Pause and Rewind	69.0	73.9
Multiple Tutorials	66.0	70.7
Diagram and Picture	73.8	79.4
Specific Font	67.8	60.9
Reading on Phone	69.5	65.1
Narrow Columns	69.8	63.5
Object Placeholder	69.3	71.0
Line Tracker Software	67.7	64.7
Highlight and Underline	72.6	74.6
Circling	74.1	74.4
Reducing Glare	68.6	68.2
Reducing Contrast	74.0	71.3
Increasing Light	N/A	N/A
Decreasing Light	N/A	N/A
Print Coloured Paper	69.9	72.5

Strategy	D-A	ND
Coloured Background	68.8	69.7
Coloured Overlays	64.5	67.6
Coloured Glasses	64.5	73.0
Video Substitution	68.3	70.4
Audiobooks	70.0	67.9
Text Scanner Personal	67.1	56.9
Screen Reader Personal	72.5	71.5
Reading Aloud	68.5	74.9
Soft Music	68.9	68.2
Loud Music	67.1	59.6
Quiet Space	73.0	79.5
Low Background Noise	67.8	70.5
High Background Noise	68.9	52.4
Packaged Spell Checker	70.1	75.4
Packaged Grammar Check	71.8	74.3
Separate Spell Checker	63.5	70.5
Separate Grammar Check	70.1	67.7

5.5.2 'Class' strategies helpfulness judgment comparisons

Average helpfulness ratings for 'Class' strategies (Figure 13) range from 60 to 80, and most SEM bars overlap. Results of individual t-tests for each strategy did not indicated any statistically significant differences between groups in average helpfulness ratings at the $p < 0.01$ level (Appendix 4).

Figure 13. Average helpfulness ratings for 'Class' strategies by participants who used them

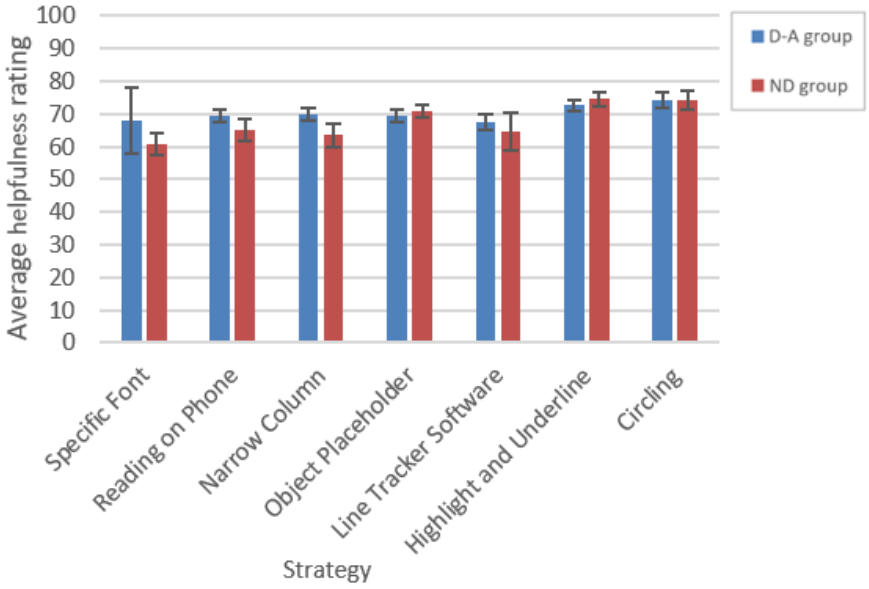


Qualitative comments on perceived helpfulness of 'Class' strategies were offered by four D-A and eight ND participants. All comments were positive about the strategies they referred to. Most described how strategies were used, or explained why they were considered helpful. No clear differences were evident between D-A and ND group comments.

5.5.3 'Visual Layout' strategies helpfulness judgment comparisons

For 'Visual Layout' strategies (Figure 14), all average helpfulness ratings fall between 60 and 75, and most SEM bars overlap. All differences between groups are non-significant at the $p < 0.01$ level according to t-test results (Appendix 4).

Figure 14. Average helpfulness ratings for 'Visual Layout' strategies by participants who used them

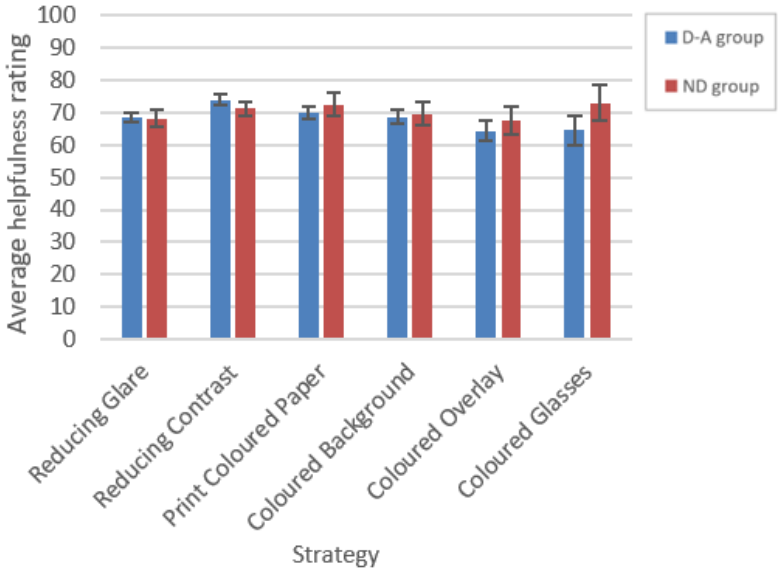


Two D-A participants and five ND peers offered qualitative comments on perceived helpfulness of 'Visual Layout' strategies. Both comments from D-A participants and three from ND participants indicated the importance of highlighting. One participant in each group mentioned fonts, with the D-A participant stating "I can make the font bigger", and the ND participant indicating "I personally find sans-serif fonts to aid readability, which is why I prefer Arial". Three other strategies were mentioned by one participant from each group, all in a positive manner: 'Object Placeholder', 'Reading on Phone', and 'Circling'.

5.5.4 'Visual Environment' strategies helpfulness judgment comparisons

For 'Visual Environment' strategies (Figure 15), all average helpfulness ratings are between 64 and 74, and most SEM bars overlap. T-test results did not indicate any significant differences between groups at the $p < 0.01$ level (Appendix 4).

Figure 15. Average helpfulness ratings for 'Visual Environment' strategies by participants who used them

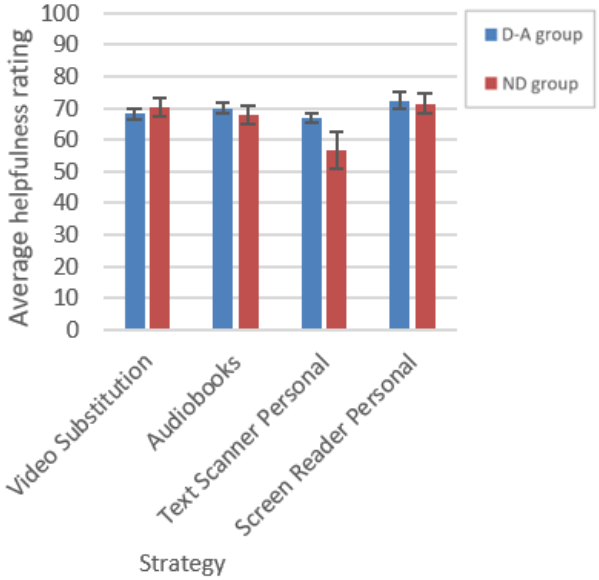


Three D-A participants and four ND participants made comments on perceived helpfulness of 'Visual Environment' strategies. All comments were positive, except one from a D-A participant, who stated: "Using coloured paper is just as hard as white I find it better if it is broken e.g. blue all around and a white or yellow bar for the line I am working on."

5.5.5 'Reading Substitution' strategies helpfulness judgment comparisons

Average helpfulness ratings for all 'Reading Substitution' strategies (Figure 16) are between 56 and 73, and most SEM bars overlap. All differences between groups were non-significant at the $p < 0.01$ level according to t-tests (Appendix 4).

Figure 16. Average helpfulness ratings for 'Reading Substitution' strategies by participants who used them

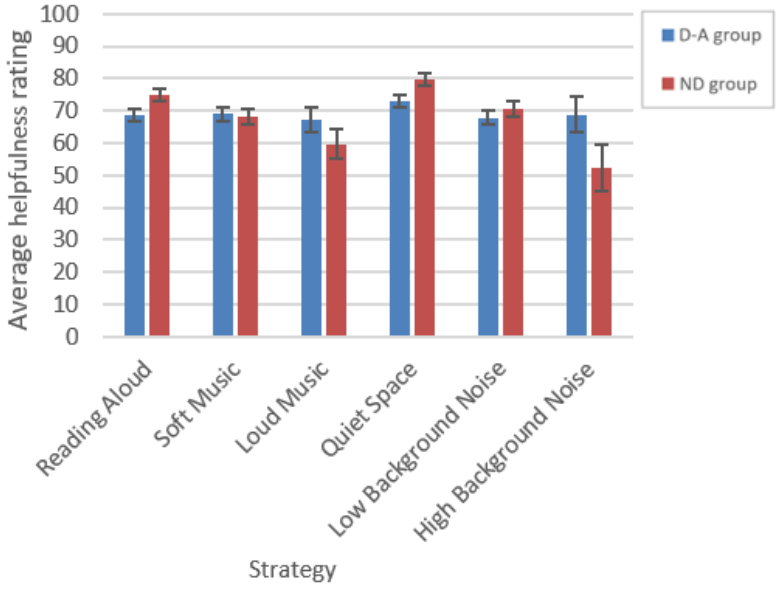


For ‘Reading Substitution’ strategies, five participants from each group made qualitative comments. One comment from the D-A group and three from the ND group related to video substitution. The D-A participant indicated that the type of video mattered, stating that inclusion of voices was important. Two ND comments were positive, but one indicated a preference for reading over videos. Regarding audiobooks, one D-A participant made a positive comment: “[Listening] to books is so much easier than reading them”. By contrast, the single comment from an ND participant about audiobooks was negative: “Audio books I find I zone out and have to keep going back for information”. Additionally, one D-A participant commented on a reading substitution strategy not included in the survey, stating: “Podcasts are also extremely helpful”. No ND participants mentioned other substitution strategies.

5.5.6 ‘Auditory’ strategies helpfulness judgment comparisons

Average helpfulness ratings for ‘Auditory’ strategies (Figure 17) are all between 60 and 80, and many SEM bars overlap. No differences between groups were found to be statistically significant (Appendix 4).

Figure 17. Average helpfulness ratings for ‘Auditory’ strategies by participants who used them

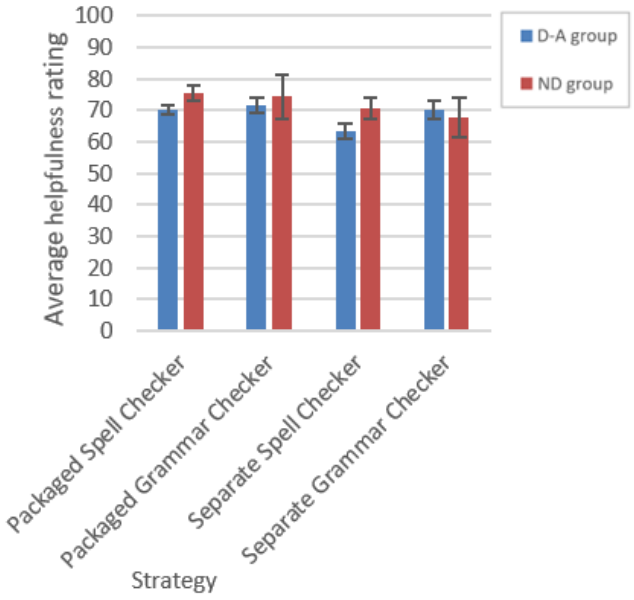


Regarding ‘Auditory’ strategies, D-A participants made four comments and ND participants made five. Most mentioned ‘Quiet Space’, which attracted one positive and two negative statements from D-A participants, compared to five positive statements from ND participants. ND participants also commented positively about reading aloud and low background noise, and one commented negatively about high background noise. D-A participants did not comment on any other surveyed strategies, but one D-A student made a general comment: “Steel oneself”.

5.5.7 'Spelling and Grammar' strategies helpfulness judgment comparisons

For 'Spelling and Grammar' strategies (Figure 18), all average helpfulness ratings are between 63 and 76, and most SEM bars overlap. T-test results did not show any significant differences between groups (Appendix 4).

Figure 18. Average helpfulness ratings for 'Spelling and Grammar' strategies by participants who used them



Five D-A participants and one ND participant commented on helpfulness of 'Spelling and Grammar' strategies. All comments were positive, though two comments from D-A participants described limitations. One stated: "Sometimes it is American!", and another described over-reliance on the spelling and grammar checkers built-in to Microsoft Word, which was perceived as an issue.

5.6 Combined approach to rank overall perceived helpfulness of learning strategies by D-A group

As the primary interest of this research project was to discover information that may be useful for university students with dyslexia, this final analysis seeks to determine which strategies were perceived most helpful by the D-A group only. Proportions of D-A participants using each strategy are shown in Figure 19, and average helpfulness ratings displayed in Figure 20. However, meaningful inferential analysis of differences in usage rates or average helpfulness ratings between strategies was hindered by the large number of variables for the usage data and different numbers of participants for helpfulness rating data.

A quantitative descriptive analysis approach is put forward in Table 13, which combines usage rates and average helpfulness ratings by D-A participants to rank learning strategies according to overall perceived helpfulness for this group. It was deemed appropriate for this analysis to be descriptive rather than inferential, as it is an exploratory approach to combining and analysing two types of data. However, it could be extended in future research using inferential methods.

Figure 19. Proportions of participants in the D-A group using each learning strategy, organised by categories

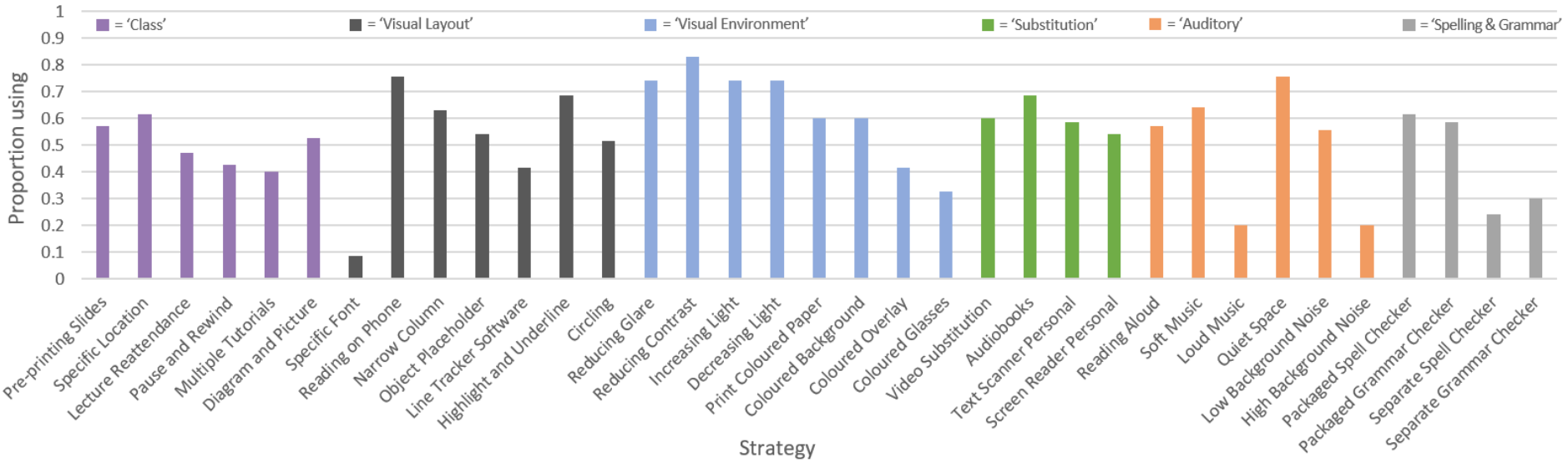
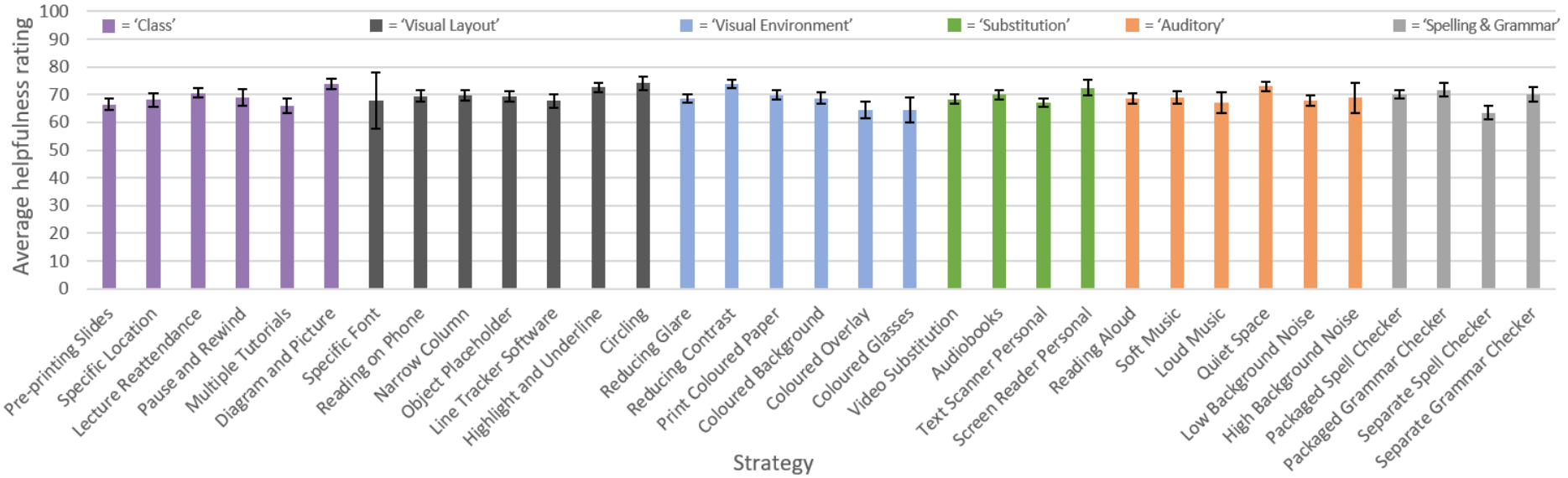


Figure 20. Average helpfulness ratings by D-A participants who had used them, organised by categories



Combined perceived helpfulness estimates were calculated for each learning strategy by multiplying the proportion of D-A participants who had used each strategy by the average helpfulness ratings of D-A participants for those strategies. Table 13 presents the results in ranked order, starting with the highest ranked strategy calculated by this approach, and proceeding down to the lowest.

Table 13. Learning strategy rankings from combined perceived helpfulness approach for D-A group

Strategy	**Proportion using**	**Helpfulness rating**	**Proportion x rating**	**Rank**
Reducing Contrast	82.9%	74.0	6135	1
Quiet Space	75.7%	73.0	5526	2
Reading on Phone	75.7%	69.5	5261	3
Reducing Glare	74.3%	68.6	5097	4
Increasing Light	74.3%	-----	-----	-----
Decreasing Light	74.3%	-----	-----	-----
Highlight and Underline	68.6%	72.6	4980	5
Audiobooks	68.6%	70.0	4802	6
Soft Music	64.3%	68.9	4430	7
Narrow Columns	62.3%	69.8	4349	8
Packaged Spell Checker	61.4%	70.1	4304	9
Packaged Grammar Check	58.6%	71.8	4207	10
Print on Coloured Paper	60%	69.9	4194	11
Specific Location	61.42%	68.1	4183	12
Coloured Background	60%	68.8	4128	13
Video Substitution	60%	68.3	4098	14
Screen Reader Personal	54.3%	72.5	3937	15
Text Scanner Personal	58.6%	67.1	3932	16
Reading Aloud	57.1%	68.5	3911	17
Diagram and Picture	52.9%	73.8	3904	18
Circling	51.4%	74.1	3809	19
Pre-printing Slides	57.1%	66.5	3797	20
Low Background Noise	55.7%	67.8	3776	21
Object Placeholder	54.3%	69.3	3763	22
Lecture Reattendance	47.1%	70.6	3325	23
Pause and Rewind	42.9%	69.0	2960	24
Line Tracker Software	41.4%	67.7	2803	25
Coloured Overlays	41.4%	64.5	2670	26
Multiple Tutorials	40%	66.0	2640	27
Coloured Glasses	32.9%	64.5	2122	28
Separate Grammar Check	30%	70.1	2103	29
Separate Spell Checker	24.3%	63.5	1543	30
High Background Noise	20%	68.9	1378	31
Loud Music	20%	67.1	1342	32
Specific Font	8.6%	67.8	583	33

In the next chapter, these results will be discussed in the context of previously published research and other scholarly literature on these topics.

CHAPTER 6: DISCUSSION

The following discussion situates key results in the broader context of previously published academic research literature on these topics. It also considers limitations of this study, implications of the study findings for key stakeholder groups, and future research directions.

6.1 Results in the context of the research literature

6.1.1 Perceived strengths at university

Although the possibility that students with dyslexia may bring specific academic strengths to university is an attractive one, the findings of this study do not support this proposition. No significant differences were found in proportions of D-A and ND participants who identified any of the potential academic strengths surveyed: deep learning, active learning, resilience, creative problem-solving, teamwork, or class participation. This finding adds to a fractured and inconclusive body of evidence about potential strengths of students with dyslexia at university, as summarised in Table 6. This new result suggests students with dyslexia do not identify any of the surveyed academic strengths in greater proportions than non-dyslexic peers. However, it should be noted that self-perception of 'Advanced Vocabulary' was not surveyed due to difficulty gaining valid and reliable data on this characteristic from an online self-report survey.

While none of the academic strengths surveyed seemed to represent perceived strengths compared to non-dyslexic peers, they may still represent areas of strength for D-A students relative to other challenges. If so, greater understanding of them may have practical benefits for D-A students, if relative strengths can be harnessed and amplified. Furthermore, some of these potential strengths may have been true differential strengths of some individual D-A students compared to other D-A students and ND peers. This is consistent with current thinking that dyslexia may have multiple subtypes with different underlying causes, and different profiles of strengths and difficulties (Friedmann & Coltheart, 2018). Further exploration may be warranted to analyse possible academic strength of D-A students with different dyslexia subtypes.

Another possible explanation of these results is that the binary proportion data collected for perceived academic strengths may not have been adequate to detect a real effect. A different type of measurement such as continuous rating scales may provide greater insights. This could be important to investigate, to ensure potentially real strengths have not been overlooked.

6.1.2 Perceived challenges at university

Regarding perceived challenges at university, a consistent pattern emerged in the study data, with D-A students rating every learning and assessment activity surveyed significantly more difficult than ND peers, except essay exams. These results provide new evidence which challenges assertions by Madriaga et al. (2010) that all university students experience similar learning and assessment challenges, regardless of dyslexia or other declared disability. These findings also suggest that data collection using a continuous rating scale may be more sensitive than previous methods for detecting perceived difficulties among students with dyslexia compared to non-dyslexic peers. These contributions could both be important to ongoing research.

6.1.3 Learning strategies used at university

Usage patterns for learning strategies offer strong indicators of perceived helpfulness, especially where all strategies have been rated similarly helpful by those who used them. Usage proportions differed significantly between the D-A and ND groups for many learning strategies. These will be delineated and discussed below. Strategies reported by high proportions of both groups will also be discussed.

Among 'Class' strategies, two significant differences were found between D-A and ND usage rates. Firstly, a significantly greater proportion of D-A participants reported attending multiple tutorial groups for the same subject, compared to ND counterparts (D-A 40%; ND 19%). This was possibly the most time-consuming learning strategy surveyed, and not standard academic practice. Yet nearly half of D-A students reported attending multiple tutorial groups, approximately twice the rate of ND students. This time-consuming practice may reduce time available for employment, family responsibilities and social activities.

The second 'Class' strategy with a significant between-group difference was 'Pause and Rewind', which was used by a smaller proportion of D-A than ND participants (D-A 42.9%; ND 72.4%). This finding adds to an inconclusive body of research on this topic. Four previous qualitative or non-comparative studies have indicated use of this strategy by university students with dyslexia (MacCullagh et al., 2017; Olofsson et al., 2012; Pollak, 2002; Serry et al., 2018), and one quantitative comparative study has provided limited evidence for greater use by students with dyslexia compared to non-dyslexic peers (Leadbeater et al., 2013). None of these studies indicated lesser use of 'Pause and Rewind' by D-A than ND students.

Available literature does not offer any theoretical or practical explanation for lesser use of 'Pause and Rewind' by D-A compared to ND participants. A possible explanation could be that students with dyslexia may have been attending more face-to-face lectures and tutorials, and only watching lecture videos to fill in gaps in their notes, not as their initial source of this information. This would be consistent with findings from MacCullagh et al. (2017) that students with dyslexia value face-to-face lectures. By contrast, ND participants may choose not to attend face-to-face classes, instead relying solely on lecture videos, hence necessitating more pausing and rewinding as they watch the lecture for the first time. This explanation, however, is only conjecture. Further investigation is needed to establish or refute this.

Three of six 'Visual Layout' strategies were found to be used by significantly higher proportions of D-A than ND participants: 'Reading on Phone' (D-A 75.7%; ND 53.4%); 'Narrow Columns' (D-A 62.3%; ND 39.7%); and 'Line Tracker Software' (D-A 41.4%; ND 15.5%). This adds weight to research findings that short line length is helpful for people with dyslexia (Schneps et al., 2013a; Schneps et al., 2013b). Other display adjustments enabled by reading on phones or e-readers, such as adjusting letter spacing, have also been found beneficial (Marinus et al., 2016; Schneps et al., 2013a). However, findings of a recent experimental study suggest adults with dyslexia may comprehend text better from a printed copy than an e-book (Cavalli et al., 2019). This is consistent with previous qualitative findings that some university students with dyslexia preferred printed course readers (MacCullagh et al., 2017). Results of the current study are consistent with such findings

supporting the importance of hard-copy books as an option for students with dyslexia. Greater proportions of students from the D-A group than the ND group reporting use of 'Owned Books' (D-A 74%; ND 52%) and 'Library Books' (D-A 77%; ND 43%). Taken together, these various findings suggest an ideal approach could be to offer easy access to multiple reading formats in university libraries, including hard-copy versions and easily manipulable electronic formats. Students could then choose whichever best suits their needs.

Lower usage rates by D-A than ND participants for two other 'Visual Layout' strategies, namely 'Highlight and Underline' (D-A 68.6%; ND 84.5%) and 'Circling' (D-A 51.4%; ND 70.7%), extend previous research that reported these strategies are used by students with dyslexia, but did not reveal a specific benefit for dyslexic students compared to non-dyslexic peers (Andreassen et al., 2017; Griffin & Pollak, 2009; MacCullagh et al., 2017; O'Byrne et al., 2019; Olofsson et al., 2012; Pirttimaa et al., 2015). A possible explanation for lower usage of these 'Visual Layout' strategies by the D-A group could lie in the greater proportions of D-A participants that indicated using technology-based strategies such as 'Audiobooks' and 'Screen Reader Personal', which may not enable easy highlighting, underlining, or circling. It is also noteworthy that proportions of the D-A group using these 'Visual Layout' strategies remained high, each greater than 50%. This indicates they were still used by many students with dyslexia.

The final 'Visual Layout' strategy, namely 'Specific Font', is perhaps the most controversial, with disagreement in existing research literature about effectiveness of special fonts such as 'Dyslexie' and 'Open Dyslexic' for people with dyslexia. The current study found that use of a 'Specific Font' was reported by a significantly lower proportion of D-A than ND participants (D-A 8.6%; ND 41.4%), and was the least used strategy by D-A participants. Furthermore, only one of the D-A participants who indicated using 'Specific Font' stated using 'Dyslexia Font'. These results are consistent with findings of no benefits in reading speed or accuracy for Dyslexie or OpenDyslexic fonts compared to Arial or Times New Roman for children with dyslexia (Kuster et al., 2018; Wery & Diliberto, 2017). They are also consistent with findings from Marinus et al. (2016) of a small (7%) improvement in reading speed for children with reading difficulties using Dyslexie font compared to Arial, due mostly to larger letter spacing rather than font shape. Findings are also supported from Rello and Baeza-Yates (2013; 2016; 2017), who found both D-A and ND children benefit similarly from fonts that are sans serif, roman, and monospaced, rather than serif, proportional, and italic.

A complication in the debate about special fonts for people with dyslexia has come from French et al. (2013) who found evidence suggesting secondary school students both with and without dyslexia learn better using fonts that are more difficult to read. A systematic review by Schulz (2016) has also criticised the design of many studies about special fonts for dyslexia, questioning their internal validity. The results of the current study do not resolve the debate about efficacy of special dyslexia fonts, but they do provide new evidence that special fonts may be of limited or no benefit to adults studying at university. The combined available evidence does not seem to justify universal implementation of any specific font for student learning materials. However, it may be beneficial to provide learning materials in formats that students can adjust to individually preferred fonts.

Among 'Visual Environment' strategies surveyed, four of eight were found to be used by significantly higher proportions of D-A than ND participants: 'Reducing Contrast' (D-A 82.9%; ND 60.3%); 'Coloured Paper' (D-A 60%; ND 19%); 'Coloured Background' (D-A 60%; ND 31%); and 'Coloured Glasses' (D-A 32.9%; ND 10.3%). For another related strategy, 'Coloured Overlay', the difference in usage rates between the two groups was not statistically significant, despite an apparent descriptive difference (D-A 41.4%; ND 22.4%). Higher usage rates by D-A than ND participants for any of these strategies were unexpected in the context of meta-analysis findings of no significant effects of coloured lenses or overlays for children or adults with reading disabilities (Galuschka et al., 2014). It is possible that greater use of such strategies by university students with dyslexia could be due to placebo effects. However, it could also be possible that these strategies may provide benefits that were not measured in studies included in these meta-analyses, such as greater visual comfort or reduced visual stress while reading (Conlon, 2012; Singleton, 2012). Such perceived benefits may not easily translate to objective measures such as reading speed or accuracy, especially in well-compensated adults.

The three remaining 'Visual Environment' strategies were used by high proportions of both groups, with no statistically significant differences between groups: 'Reducing Glare' (D-A 74.3%; ND 81%); 'Increasing Light' (D-A 74.3%; ND 75.9%); and 'Decreasing Light' (D-A 74.3%; ND 81%). These results suggest that both students with and without dyslexia may benefit from these visual environment strategies. This is consistent with research that has indicated the importance of lighting characteristics such as illuminance, contrast, and glare for student comfort, learning, and satisfaction (Choi et al., 2014; Cunningham & Tabur, 2012; Erbil & Sezer, 2016; Ricciardi & Buratti, 2018; Yang et al., 2013). Further investigation of these 'Visual Environment' strategies would need to take into consideration the needs of students with low vision, hearing impairment, autism, ADHD, and other diversities. There may be a rationale for customisable lighting in universities to better meet the needs of all students, similar to workplace lighting systems evaluated by van de Werff et al. (2017). Such lighting improvements could have broad positive impacts, given the high proportions of both D-A and ND students who indicated using lighting-related 'Visual Environment' strategies.

'Substitution' strategies were strongly favoured by students with dyslexia, with three out of four used by significantly more D-A than ND participants: 'Audiobooks' (D-A 68.6%; ND 36.2%); 'Text Scanner Personal' (D-A 58.6%; ND 19%); and 'Screen Reader Personal' (D-A 54.3%; ND 25.9%). Qualitative comments from D-A participants also indicated perceived helpfulness of podcasts. Intuitively, may seem logical for students with dyslexia to use methods other than reading to gain the same information. However, previous research has provided limited evidence of differential benefit of these strategies for students with dyslexia over non-dyslexic peers. The findings of the current study offer new quantitative comparative evidence of the importance of these strategies for D-A students. Greater usage by D-A students of self-sourced audiobooks, text scanners, and screen readers, may add to financial pressure. This pattern was evident despite all these students having formal assessments for dyslexia, thus qualifying to access such technologies through university accessibility services. To improve access to these technologies, it may thus be necessary to consider other access approaches, such as making them available for use in university libraries.

High usage of 'Video Substitution' by both D-A and ND students (D-A 60%; ND 76%) suggests most students, both D-A and ND, may benefit from this strategy. This is consistent with previous qualitative findings that students both with and without dyslexia reported searching online for videos to replace or supplement prescribed readings (MacCullagh et al., 2017). It also supports research findings about benefits of multisensory learning materials both for students with and without dyslexia (Shams & Seitz, 2008; Wang et al., 2018). Together, these findings suggest it could be beneficial to add video recommendations in unit outlines, to ensure videos watched by students are of appropriate quality and relevant to course content. While suitable videos may not be available for every topic, they could be recommended where possible. Providing multiple learning formats is an integral component of universal design for learning (Burgstahler, 2015). As such, providing both video and reading recommendations is in line with established best practice for inclusive education. Despite common perceptions of reading as a 'better' way to learn, it should be noted that writing and paper are also invented technologies used to disperse knowledge further than was possible with the previous system of verbal storytelling (Dehaene, 2009). Video can thus be considered an equally valid teaching technology.

It was surprising that two 'Auditory' strategies were reported by significantly lower proportions of D-A than ND participants: 'Quiet Space' (D-A 75.7%; ND 94.8%) and 'Low Background Noise' (D-A 55.7%; ND 82.8%). Qualitative comments also suggest that some D-A participants perceived reading in a 'Quiet Space' as detrimental due to concentration difficulties under these conditions. This might be related to co-existing attentional difficulties that were more prevalent in the D-A group than the ND group.

Finally, despite spelling being a core challenge for many people with dyslexia, no significant differences were found between the D-A and ND groups for usage rates of any of the spelling or grammar strategies surveyed. These results were: 'Packaged Spell Checker' (D-A 61.4%; ND 79.3%); 'Packaged Grammar Check' (D-A 58.6%; ND 68%); 'Separate Spell Checker' (D-A 24.3%; ND 15.5%); 'Separate Grammar Check' (D-A 30%; ND 25.9%). Qualitative data indicate use of an additional 'Spelling and Grammar' strategy of human proof-readers by two D-A participants and one ND participant. Some D-A students may have also used specialised spelling and grammar software from university accessibility services. As spelling is a core challenge associated with dyslexia, and a key academic skill, it may be valuable to further explore how university students with and without dyslexia manage this requirement, and clarify which methods are most effective.

6.1.4 Average helpfulness ratings for learning strategies used

One of the most surprising results of this study was absence of significant differences in average helpfulness ratings between the D-A and ND groups for any of the surveyed learning strategies. Combined with the finding that both groups used approximately the same average number of strategies per student, this suggests D-A students may still be disadvantaged compared to ND peers even after implementing their chosen strategies.

It is concerning that the highest average rating for any strategy by the D-A group was 74.1 out of a maximum score of 100, and the highest rated strategy for the ND group was 79.5 out of 100 (Table 12, p. 48). As such, no

strategy received an average score from the D-A group in the range labelled 'Very helpful' on the continuous rating scale. This suggests the D-A group perceived the helpfulness of all surveyed strategies to be limited.

However, it is encouraging that all average helpfulness ratings were greater than 63 for the D-A group, and 52 for the ND group. All were at least in the 'Somewhat helpful' area of the continuous rating scale or a little better. This is a positive indication that students who use these strategies do perceive some benefit from them. However, it is impossible to conclude from self-report data whether these are the most effective methods available (Dunlosky et al., 2013). Experimental data is needed before such conclusions can be made.

It should be remembered that helpfulness ratings for each strategy were only collected from participants who indicated having used that strategy. As such, average perceived helpfulness scores do not reflect scores of the whole participant group, but only the sub-set who had used the strategy in question. Thus, it cannot be concluded that all participants would find the strategies similarly helpful. Students may have simply chosen to use strategies suited to their individual needs. These strategies may not be considered helpful by other students with different profiles.

6.1.5 Combined perceived helpfulness rankings of learning strategies for D-A group only

A new approach was also used to rank overall perceived helpfulness of learning strategies by the D-A group only. Usage proportions and average helpfulness ratings for each strategy were combined into a single estimate of perceived helpfulness for each strategy (Table 13, p. 54). Across this field of research, a combined measure such as this may provide more holistic estimates of perceived helpfulness than those based on a single measure of either usage or helpfulness.

The benefit of combining usage proportions and average helpfulness ratings is to provide richer information about likelihood that a strategy will be helpful. In a hypothetical scenario, if a high proportion of dyslexic students uses a strategy and rate it more helpful on average than other strategies, it may be more likely that an individual student with dyslexia trying that same strategy will find it helpful. By contrast, if a high proportion of students with dyslexia use a strategy, but rated its helpfulness very poorly, this strategy could be less likely to be helpful to other students with dyslexia. Without both pieces of information, it might have been concluded that the second strategy was helpful for students with dyslexia, but this inference would have been incorrect.

Among the ten highest ranked strategies for D-A students according to this approach, five were vision-based, two auditory-based, two related to spelling and grammar, and one reading substitution. The five vision-based strategies were ranked first, third, fourth, fifth, and eighth: 'Reducing Contrast', 'Reading on Phone', 'Reducing Glare', 'Highlight and Underline', and 'Narrow Columns'. Two further vision-based strategies had high usage rates but were not included in overall rankings due to lack of helpfulness rating data: 'Increase Light'; and 'Decrease Light'. High ranking of visual strategies suggests that although visual dyslexia is only one of ten recognised subtypes (Friedmann & Coltheart, 2018), some students with other subtypes also perceive visual

strategies helpful. The two auditory-based strategies and one substitution strategy were ranked second, sixth, and seventh: 'Quiet Space', 'Audiobooks', and 'Soft Music'. The two final strategies in the top ten rankings were spelling and grammar based: 'Packaged Spell Checker' and 'Packaged Grammar Check'. Inclusion of these two strategies is consistent with the known association of between dyslexia and spelling difficulties.

A surprising finding was that the top-ranked learning strategy for students with dyslexia was 'Reducing Contrast'. This strategy has not been mentioned in previous literature relating to university student strategies. However, the neuropsychological construct of contrast sensitivity has been investigated in experimental studies, including those by Lovegrove et al. (1980), Gross-Glenn et al. (1995), and Conlon et al. (2012). 'Reducing Contrast' was included in the current study for completeness, due to its logical association with 'Reducing Glare'. It should be noted that 'Reducing Contrast' had both the highest usage proportion by the D-A group for any strategy (82.9%) and second highest average helpfulness rating by the D-A group (74.0). As such, its high rank cannot be attributed to either factor alone. 'Reducing Contrast' was also used by a large proportion of ND group, with a similar average helpfulness rating (71.3). These findings suggest reducing contrast on computer screens and lecture slides could help both D-A and ND students. However, implications for students with low vision would need to be tested before any universal recommendations could be made.

6.2 Limitations of this study

While clear strengths informed the design of this study, there were some limitations. Most notably, possible recruitment of a non-representative sample, potential sampling bias, and reliance on self-report data. Recruitment of a non-representative sample is an almost unavoidable risk of this type of research. Samples of participants recruited to the D-A and ND groups may not proportionally represent all subsets of university students with and without dyslexia at Australian universities over the past five years. This is because identifying all eligible students in such a population and distributing a survey to all of them, or to a representative sample of them, is an almost impossible task. Hence, this limitation is common to almost all research in this area.

Sampling bias can also occur when conducting an online survey. Participation in such surveys is necessarily voluntary, and certain subgroups of the study population may be more interested or able to participate than others. For example, students managing well at university may have more time to complete a non-essential survey. Conversely, students struggling at university study may be highly motivated to have their views heard confidentially. Sampling bias can be a particular issue when recruiting from a university's accessibility service, as students concerned about privacy breaches and possible effects on services may not participate (De Cesarei & Baldaro, 2015). Dyslexic students registered with an accessibility service may also represent a sub-population better prepared to access services. To mitigate these risks for sampling bias, multiple recruitment methods were used, including posters around campus, and social media posts, in addition to an email sent by the Macquarie University accessibility service to students registered with dyslexia. The recruitment methods used for this study compare favourably to those of other studies with similar topics and populations (see Andreassen et al., 2017; Kalka & Lockiewicz, 2018; MacCullagh et al., 2017).

Another unavoidable limitation of an online survey is reliance on participant self-report, which could have introduced inaccuracies or bias (Johnson & Christensen, 2016). Inaccuracies may have occurred if participants did not correctly recall their experiences, or misunderstand survey questions and thus answered incorrectly. This risk was mitigated by having voice narration built into the survey, and by providing response options such as 'Not sure' and 'Don't remember', and by. However, it is still possible that some 'Yes' or 'No' responses may have been inaccurate. Systematic response bias may have occurred if participants perceived their strengths, challenges, and strategies more positively or negatively than objective measures might indicate, or if they consciously or subconsciously answered survey questions to prove an agenda or to 'help' the researchers (De Cesarei & Baldaro, 2015; Johnson & Christensen, 2016). This risk was partially managed by the robust sample size, systematic ordering of questions, and use of numeric rating scales where possible. These approaches were consistent with the principles provided by De Cesarei & Baldaro (2015) for conducting online surveys with university students with disabilities. However, the risk of inaccurate or biased responses could not be eliminated entirely. These limitations were considered acceptable, partly because they are common to all survey-based research, and also because the purpose of the current study was semi-exploratory to identify potential patterns that may warrant objective experimental research investigation.

6.3 Implications for key stakeholder groups

The findings of this research have numerous implications and potential uses for stakeholder groups including university students with dyslexia, teaching staff, course coordinators, librarians, accessibility service staff, university study skills advisors, advocacy groups, and policymakers.

6.3.1 Implications for students with dyslexia

The most important implications of this research are for students with dyslexia. Learning strategies ranked highest in the combined model for estimating overall perceived helpfulness indicated those that were rated most helpful by the largest proportions of students with dyslexia. As such, they could be more likely to be helpful than others, and thus worth trying first if time is limited. The four learning strategies with the highest ranks may be ideal to try first: 'Reducing Contrast', 'Quiet Space', 'Reading on Phone', and 'Reducing Glare'.

6.3.2 Implications for teaching staff, course coordinators, and librarians

Though teaching and course design strategies were not the focus of this research, some patterns that emerged may be of interest to lecturers, tutors, course coordinators, and librarians. Findings suggest multiple types of learning resources perceived as helpful, but no one format clearly preferred. As such, the key to meeting the needs of students both with and without dyslexia may be to offer learning materials in multiple formats, so that students can select whichever best suit their needs. Important formats could include hard-copy textbooks, printable course readers, e-readers, audiobooks, and video recommendations. Such measures would be consistent with principles of universal design for inclusive education.

6.3.3 Implications for accessibility service staff and university study skills advisors

Findings on differential use of various learning strategies by students with dyslexia compared to other students may be of key relevance to accessibility service staff and university study skills advisors. In generic study skills classes for all students, it may be ideal to prioritise information about learning strategies used by high proportions of students both with and without dyslexia. In groups or consultations specifically for students with dyslexia, it may be beneficial to focus on strategies used by significantly greater proportions of dyslexic than non-dyslexic students. Findings from this thesis can be used to guide development of tailored learning skills training to suit specific needs of students with and without dyslexia.

6.3.4 Implications for policymakers

University and government policymakers can also gain important information from this research to help increase retention and success of students with dyslexia at university.

Evidence presented in this thesis suggests university students with dyslexia experience disadvantage compared to non-dyslexic peers. Students with dyslexia rated every learning activity surveyed, and all but one assessment activity, significantly more difficult on average than non-dyslexic students. No differential academic strengths were identified to compensate for these challenges. Furthermore, greater proportions of students with dyslexia than those without used time-consuming and expensive strategies such as attending multiple tutorial groups for the same subject and purchasing specialised technology such as text scanners and screen readers. Use of these strategies may reduce time available for employment or home responsibilities, and money for living expenses, further contributing to economic and educational disadvantage.

For university policymakers, these findings suggest a rationale for allowing students with dyslexia extended time to complete degrees, including longer duration of university scholarships. For government policymakers, these findings similarly indicate a rationale for allowing longer duration of Youth Allowance, Austudy, or other student support payments for this student group. Additionally, these findings also support introduction of an allowance in Australia similar to the 'Disabled Students Allowance' in the UK to assist with expenses associated with university study. This could help level the playing field for university students with dyslexia.

Data about the learning resources students with dyslexia perceive as helpful may also have implications for library funding. Maintaining access to a variety of resource formats, including hard-copy textbooks, printable course readers, e-readers, audiobooks, and multimedia, may have implications for physical and technological infrastructure requirements. Provision of other resources such as text scanners and screen reading software through library systems would also require appropriate resource allocation. Information from this study may provide additional evidence to inform these funding decisions.

Indications from this study sample also implicate the time and expense of formal testing as barriers to disclosure and service access for many students with dyslexia. Government policymakers could address this issue by subsidising or providing full rebates for formal dyslexia testing. University policymakers

could also contribute by introducing free screening tests, and advertising these during university orientation. Data regarding stigma and discrimination about disclosing dyslexia and accessing services also suggest funding may be warranted for student and staff awareness campaigns.

6.3.5 Implications for advocates

For advocates, the data presented in this thesis provide evidence to help lobby university and government policymakers. The points outlined in the preceding section offer potential areas of focus.

6.4 Future research directions

The findings of this study offer numerous avenues for further research. A key priority will be to conduct a replication study with a larger sample to confirm, refute, or modify the findings of this study. Additional strategies from the qualitative data should be included, such as creating quizzes for self-testing, and using human proof-readers. Other strategies from previous research that were too difficult to explain in this online survey may also be considered, such as use of mnemonics and rhymes. Participants would ideally be recruited systematically from every Australian university, to gain a more representative sample. Recruitment should continue until the survey has been completed by enough participants with dyslexia formally assessed (D-A), dyslexia self-identified (D-S), and non-dyslexic peers (ND) to allow robust inferential comparative analysis across these three groups. If numbers allow, subgroup analysis could also be performed across different dyslexia subtypes and different combinations of other co-existing learning differences, especially ADHD. In-depth interviews may also be conducted to confirm and clarify findings.

A logical extension would be to interview university lecturers, tutors, course coordinators, accessibility service staff, and study skills advisors for broader perspectives. This could enable triangulation of student findings to further confirm or adjust potential recommendations. Input from these additional stakeholder groups may also be beneficial for exploring barriers and enablers for implementing recommendations.

Another avenue for future research would be to conduct experimental studies on specific challenges or strategies identified in the current study, using objective measures to further explore their helpfulness for students with dyslexia. Such experiments should measure more than just reading speed and accuracy as indicators of helpfulness. Consideration should also be given to measuring other indicators such as learning effectiveness, reading effort, and reading comfort. Experimental studies on alternative assessment activities might involve comparing performance in traditional assessment formats such as essay exams to alternative assessment modalities such as oral exams or multiple smaller tests (MacCullagh et al., 2017). Experimental studies of individual learning strategies would also be beneficial. These could use objective measures to determine the effects of various strategies on reading speed, reading accuracy, and learning outcomes. Subjective measures of reading effort and comfort could also be included.

CHAPTER 7: CONCLUSIONS

The research reported in this thesis has built on previous qualitative findings of MacCullagh et al. (2017), and the broader research literature regarding potential strengths, challenges, and learning strategies of university students with dyslexia. Inferential comparisons have been made between proportions of students with and without dyslexia reporting various academic strengths, finding no significant difference between groups for any potential strength surveyed. Comparisons have also been made between average difficulty ratings by dyslexic and non-dyslexic groups for learning and assessment activities, finding consistently higher average difficulty ratings by dyslexic participants for every learning activity surveyed, and for all assessment activities except one.

Regarding learning strategies, this research has provided both quantitative usage rates and average helpfulness ratings for a wide range of strategies previously reported in the research literature. Significant between-group differences in usage proportions were indicated for 17 of 35 strategies surveyed. Eleven were used by significantly greater proportions of the D-A group, and six by significantly greater proportions of the ND group. Those used by significantly greater proportions of D-A than ND participants were: 'Multiple Tutorials', 'Reading on Phone', 'Narrow Columns', 'Line Tracker Software', 'Reducing Contrast', 'Coloured Paper', 'Coloured Background', 'Coloured Glasses', 'Audiobooks', 'Text Scanner Personal', and 'Screen Reader Personal'. For average helpfulness ratings, no significant between-group differences were found for any strategy. This information could help university study skills advisors and dyslexia tutors decide which strategies to teach to all students and which to focus on specifically for students with dyslexia.

A new approach was also used to rank overall perceived helpfulness of various strategies for D-A participants by combining usage proportions and average helpfulness ratings into a single numeric estimate for each strategy. According to this descriptive analysis, the ten highest ranked strategies, starting with the highest, were: 'Reducing Contrast', 'Quiet Space', 'Reading on Phone', 'Reducing Glare', Highlight and Underline', 'Audiobooks', 'Soft Music', 'Narrow Columns', 'Packaged Spell Checker', and 'Packaged Grammar Check'. This information may be useful to university students with dyslexia when deciding which strategies to try when time is limited. Ultimately, this may contribute to greater wellbeing and academic success for university students with dyslexia.

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APPENDIX 1: SURVEY QUESTIONS – Version for students WITH reading difficulties

You are invited to complete this survey

Click the speaker button for audio narration, followed by the text you wish to hear.

This survey will take approximately 35-45 minutes to complete. You can complete it all at once, or return to it for up to 14 days on the same device and your progress will be saved.

If this study causes distress, you can contact the study supervisor, Dr Agnes Bosanquet, t: 02 9850 9790, e: agnes.bosanquet@mq.edu.au.

Or for free counselling, call Mental Health Line 1800 011 511 or LIFELINE 13 11 14.

Please read the participant information below or click the speaker button to listen to it.

((Insert participant information displayed as in-line text – Dyslexic version))

If you wish to download a copy of the participant information, click the document link below.

((Insert document link – Dyslexic version))

Participant eligibility and consent

((Insert eligibility and consent wording and tick-boxes here – Dyslexic version))

Administrative information

Topic	Questions and response options
Device type	What kind of device are you currently using to do this survey? Laptop computer Desktop computer Tablet Mobile phone Note: The text-to-voice narration feature in this survey does not work on some mobile devices. If you wish to use this feature, please complete the survey on a laptop or desktop computer.
Headphones	What kind of headphones or speakers are you using? Headset Ear buds Computer speakers None Note: If you wish to use the text-to-voice narration in this survey, you will need headphones or speakers.
Surroundings	Are you in a private and quiet space? Yes / No Please move to a comfortable space before you continue.

Demographic information

Topic	Questions
Age	What is your current age? 18 / 19 / 20 / 21 / 22 / 23 / 24 / ..... / 90
Gender	What is your gender? Male / Female / Non-binary / Prefer not to say
Handedness	Which hand do you write with? Right / Left / Both

Learning differences

Topic	Questions
Dyslexia assessment	Have you been formally assessed as having a reading difficulty or dyslexia? Yes / No / Not sure
	If 'yes' to formal assessment: How old were you when you were assessed? 2-5 years / 6-10 / 11-15 / 16-20 / 21-25 / 26-30 / 31-35 / 36-40 / 41-45 / 46-50 / 51-55 / 56-60 / Older than 60 Who conducted your assessment? Educational psychologist Speech pathologist Teacher or lecturer Other (please specify below) If 'other' above, please specify who conducted your formal assessment: *((Free text response field))* Were you told a dyslexia sub-type? No, I wasn't told a subtype Possibly, but I can't recall it Yes, Letter position sub-type Yes, Attentional subtype Yes, Letter identity sub-type Yes, Neglect sub-type Yes, Visual sub-type Yes, Surface sub-type Yes, Phonological sub-type Yes, Vowel letter sub-type Yes, Deep sub-type Yes, Access to semantics sub-type Do you remember how much the assessment cost? Yes / No / Not sure *If 'yes' to remembering cost:* What was the approximate cost of your assessment in Australian dollars (AUD)? *((Number entry field))*
	If 'no' or 'not sure' to formal assessment: Do you identify as having a reading difficulty or being dyslexic? Yes / No / Not sure *If 'yes' to self-identifying (after 'no' to formal assessment):* Why haven't you sought a formal assessment? It would take too long / It's too expensive / I don't see any benefit / Other (please specify below) If 'other' above, please specify reason for not seeking a formal assessment: (Optional) *((Free text response field))*

Redirection	***If 'no' to both formal assessment and self-identification:*** For this arm of the study we are only recruiting people with confirmed or suspected reading difficulties. If you do not believe you have a reading difficulty and wish to participate please copy this link --- <<link>> --- into your web browser for an equivalent survey.
Dyslexia disclosure	Did you disclose your reading difficulty when you enrolled at university? Yes / No *If 'no' to disclosing:* What were your reasons for not disclosing? Concerned about potential discrimination Did not want different treatment Could not see any benefit Other (please specify below) If 'other' above, please specify reason for not disclosing your reading difficulty: (Optional) *((Free text response field))*
Other learning differences	Have you been formally assessed as having any other learning difference(s)? None Dyscalculia (difficulty with numbers and maths) Dyspraxia (difficulty with coordination) Attention deficit hyperactivity disorder (ADHD) Autism spectrum Other (please specify below) If 'other' above, please specify the learning difficulty you have been formally assessed with: *((Free text response field))* Do you believe you identify as having any other learning differences? None Dyscalculia (difficulty with numbers and maths) Dyspraxia (difficulty with coordination) Attention deficit hyperactivity disorder (ADHD) Autism spectrum Other (please specify below) If 'other' above, please specify the learning difficulty you identify as having: *((Free text response field))*
Other learning difference disclosure	*If any other learning difference selected above:* Did you disclose these when you enrolled at university? Yes / No / Not sure *If 'no' to disclosing other learning difference:* What was your reason/s for not disclosing? Concerned about potential discrimination Did not want different treatment Could not see any benefit Other (please specify below) If 'other' above, please specify reason for not disclosing this learning difference or differences: (Optional) *((Free text response field))*
Tip	Tip: You're going well! Take a few moments to look around the room before continuing

Reading experiences

Topic	Questions
Early reading difficulties	How much difficulty did you have learning to read in primary school? None Not much Some Quite a bit A great deal I don't remember
High school difficulties	How much difficulty did you have with reading in high school? None Not much Some Quite a bit A great deal Compared to your classmates in high school, how was your reading speed? Clearly above average Somewhat above average Average Somewhat below average Clearly below average
University reading	On average, approximately how many readings per week does your university course require (including book chapters, journal articles and other compulsory readings)? 0 / 1-5 / 6-10 / 11-15 / 16-20 / 21-25 / 26-30 / More than 30 In general, how many of your course readings do you complete? 0 / 1-5 / 6-10 / 11-15 / 16-20 / 21-25 / 26-30 / More than 30 Approximately how many hours do you spend on your required university readings each week? 0 hours / 1-5 / 6-10 / 11-15 / 16-20 / 21-25 / 26-30 / 31-35 / 36-40 / More than 40 How do you read your university readings? (Select all that apply) Printed on paper In books that I own In books from the library Online with text-to-speech software Online without text-to-speech software I don't read them Other (please specify below) If 'other' above, please specify how you do your university readings: *((Free text response field))*
Reading speed	Compared to your peers, how do you rate your current reading speed? Clearly above average Somewhat above average Average Somewhat below average Clearly below average

Current reading difficulty	How much difficulty do you currently experience when reading? None Not much Some Quite a bit A great deal	
Reading enjoyment	How do you feel about reading? Very positive Somewhat positive Neutral Somewhat negative Very negative	
Reading accuracy	How often do you experience the following?	
	Read words incorrectly when reading silently	Never Sometimes Very often 0 50 100
	Reversing the order of letters or numbers when reading or writing	0 50 100
	Accidentally reading the same line of text twice or more	0 50 100
	Accidentally skipping one or more lines of text	0 50 100
Reading perceptions	Do you ever perceive any of the following while reading? Please select all that apply: Seeing words or letters move around the page or screen Seeing words or letters backwards Seeing words or letters jumbled Seeing the wrong words or letters Reading but not absorbing the meaning Feeling very sleepy after reading for a short time (when not otherwise tired) None of these	

Spelling experiences

Topic	**Questions**
Spelling difficulty	How difficult do you find it to spell words correctly? Very easy Average Very difficult 0 50 100
Spelling accuracy	How often do you spell words incorrectly? Never Sometimes Very often 0 50 100
Tip	Tip: Wiggle your arms, legs, fingers and toes before you go on

Visual characteristics

Topic	Questions
Visual acuity	Have you been prescribed glasses or contact lenses? Glasses / Contact lenses / Neither
	If 'glasses' or 'contact lenses' selected: Do you wear them when reading? Yes / No Are you wearing them now? Yes / No Do you know if you are short- or long-sighted? I'm short-sighted I'm long-sighted Neither Don't know Do you know your script? Yes / No *If 'yes' to knowing script:* What is the script in your left eye? (including plus or minus sign and how many diopters) *((Free text response field))* What is the script in your right eye? (including plus or minus sign and how many diopters) *((Free text response field))* Do you have astigmatism? Yes / No / Don't know Do you wear bifocals or multifocals? Bifocals / Multifocals / Neither Do you know if your script is stronger in one eye or the other? Yes, it's stronger in my left eye Yes, it's stronger in my right eye No, it's the same in both eyes Not sure
	For all respondents: Do you think you see better with one eye than the other? Yes, I think I see better with my right eye Yes, I think I see better with my left eye No, I see the same in both eyes Not sure Do you ever notice one eye getting tired or turning in towards your nose more than the other? Yes / No Have you ever had vision therapy that involved wearing a patch over one eye? Yes / No

Eye health	Do you have any other vision or eye health issues? None Glaucoma Colour blindness Macular degeneration Sensitivity to glare Other (Please specify below) If 'other' above, please specify the visual or eye health issue: *((Free text response field))*
Visual processing	Do you ever tilt your head to one side or the other when reading? Yes / No / Not sure Do you ever tilt your book or paper to read? Yes / No / Not sure Do you ever close one eye when reading? Yes / No / Not sure Have you ever been to a three dimensional (3D) movie? Yes / No / Not sure *If yes to going to a 3D movie:* When watching a 3D movie, did you perceive the 3D effect? Yes / No / Not sure Did you experience any negative effects during or after watching a 3D movie? None Headache Eye strain Dizziness Nausea Other (Please specify) If 'other' above, please specify the negative effect you experienced: *((Free text response field))*

Auditory characteristics

Auditory acuity	Have you ever had a hearing test? Yes / No / Not sure
	If 'yes' to having a hearing test: Do you know the results of your hearing test? Normal hearing Conductive hearing loss Sensorineural hearing loss Mixed hearing loss Not sure *If 'yes' to any of the four types of hearing loss listed:* Do you know the extent of any loss? None / Mild / Moderate / Profound / Not sure

Ear health	Have you had frequent ear infections at any stage? Select all that apply: Yes, as a child (aged 0-12) Yes, in high school (aged 13-17) Yes, as an adult (aged 18 and older) No	
Auditory processing	How often do you experience each of the following?	
	Difficulty following conversations in noisy places	Never Sometimes Very often 0 50 100
	Difficulty identifying the source of a sound you have heard	0 50 100
	Hearing the wrong words when others are talking	0 50 100
	Hear words out of synch with visual input	0 50 100
Tip	Tip: Look left, right, up and down before you go on	

Education experiences

Topic	**Questions**			
Explanatory text	You've now completed the first half of the survey. The following section will ask a series of questions about your educational experiences from childhood to today. Please continue when ready.			
Highest qualification	Which of the following education have you undertaken? And how far have you progressed?			
		Not started	Started	Completed
	High school – year 10	○	○	○
	High school – year 12	○	○	○
	Vocational or trade certificate	○	○	○
	Vocational or trade diploma	○	○	○
	University – Bachelors degree	○	○	○
	University – Graduate certificate	○	○	○
	University – Graduate diploma	○	○	○
	University – Masters by coursework	○	○	○
	University – Masters by research	○	○	○
	University – Doctorate (PhD)	○	○	○

Deferral or discontinuation	Have you ever deferred or discontinued any of your studies due to reading difficulties? Yes – Deferred Yes – Discontinued No *If 'yes' to deferred:* What qualification did you defer? (Optional) *((Free text response field))* *If 'yes' to discontinued:* What qualification did you discontinue? (Optional) *((Free text response field))*
Time of study	In what year did you *start* high school (year 7)? *((Numeric text response field))* In what year did you *finish* year 10? *((Numeric text response field))* In what year did you *finish* year 12? *((Numeric text response field))* Are you currently enrolled at university? Yes Yes, but I'm on a leave of absence No
	If 'yes' or 'yes, but on leave of absence': In what year did you start your current degree? *((Numeric text response field))* Is your current degree part-time or full-time? Part-time / Full-time
	If 'no' to current enrolment: In what year did you ***start*** your most recent degree? 2015 / 2016 / 2017 / 2018 / 2019 Was your most recent degree part-time or full-time? Part-time / Full-time
Strengths	What do you consider your strengths in an education setting? Deep learning Creative problem solving Resilience Teamwork Class participation Active learning Other (Please specify below) If 'other' above, please describe your strengths in an educational setting: *((Free text response field))*

Challenges – Study tasks	How difficult do you find the following study activities?	
	Taking notes	Very easy Neutral Very difficult 0 50 100
	Organising notes	0 50 100
	Organising time	0 50 100
	Reading text books	0 50 100
	Reading journal articles	0 50 100
	Practical work	0 50 100
Challenges – Assessments	How difficult do you find the following study activities?	
	Group assessment tasks	Very easy Neutral Very difficult 0 50 100
	Essay assignments	0 50 100
	Class presentations	0 50 100
	Multiple choice exams	0 50 100
	Essay exams	0 50 100
	Short answer exams	0 50 100
Tip	Stand up and stretch before continuing.	

Accessibility services

Explanatory text	This section asks about accommodations provided through the accessibility service at your university. At some universities, this service may be called the 'Equity Service', 'Disability Service' or some other name. Please continue when ready.			
Registration	Have you registered with the university accessibility service for accommodations related to reading difficulty? Yes / No *If 'no' to registering:* What were your reasons for not registering? Did not want services Did not have time to register Don't believe the services would be helpful The tests required to register are too expensive The tests required are too time-consuming The delay for tests was too long The delay for an accessibility consultation was too long Other (Please specify below) If 'other' above, please specify your reasons for not registering: *((Free text response field))*			
Note-taking Accommodations	Have you ever received any of these accommodations to assist with note-taking?			
		Yes	No but want to try it	No & don't want
	Video recordings of classes	○	○	○
	Audio recordings of classes	○	○	○
	Note taking software	○	○	○
	Personal note taker in class	○	○	○
	Have you received any other accommodations to assist with note-taking? If so, please specify: (Optional) *((Free text response field))*			
	Can you suggest any other accommodations that could assist with note-taking? If so, please specify: (Optional) *((Free text response field))*			
Assessment Accommodations	Have you ever received any accommodations for your assessments?			
		Yes	No but want to try it	No & don't want
	A reader for exams	○	○	○
	Coloured paper for exams	○	○	○
	Assistive technology for exams	○	○	○
	Extra time for exams	○	○	○
	Extensions for assignments	○	○	○

<table>
<tr><td></td><td colspan="4">If ‘yes’ to assistive technology for exams:
If you received assistive technology for your exams, please describe the type of assistive technology: (Optional)
((Free text response field))</td></tr>
<tr><td></td><td colspan="4">If ‘no but want to try it’ to assistive technology for exams:
If you would like to use assistive technology for your exams, please describe the type of assistive technology: (Optional)
((Free text response field))</td></tr>
<tr><td></td><td colspan="4">All respondents:
Have you received any other accommodations for your assessments?
If so, please specify: (Optional)
((Free text response field))
Can you suggest any other accommodations that could help with assessments?
If so, please specify: (Optional)
((Free text response field))</td></tr>
<tr><td rowspan="6">General assistive technologies</td><td colspan="4">Have you ever received any of the following assistive technologies?</td></tr>
<tr><td></td><td>Yes</td><td>No but want to try it</td><td>No & don’t want</td></tr>
<tr><td>Screen reader software</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Text scan device or software</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Daisy books</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td colspan="4">Have you ever received any other assistive technology?
If so, please specify: (Optional)
((Free text response field))
Would you like to try any other assistive technology?
If so, please specify: (Optional)
((Free text response field))</td></tr>
<tr><td rowspan="6">Tutoring and study help</td><td colspan="4">Have you ever received any tutoring or study assistance at university?</td></tr>
<tr><td></td><td>Yes</td><td>No but want to try it</td><td>No & don’t want</td></tr>
<tr><td>Reading and study skills tutoring</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Reading and study skills peer study group</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Subject-specific tutoring</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Subject-specific peer study group</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td colspan="4">Have you received any other tutoring or study help?
If so, please specify: (Optional)
((Free text response field))
Is there any other tutoring or study help you would like to receive?
If so, please specify: (Optional)
((Free text response field))</td></tr>
</table>

Service helpfulness	For any services you received, how helpful were they?			
	Video recordings of classes	Not at all helpful | 0	Somewhat helpful | 50	Very helpful | 100
	Insert next service with 'yes' response	| 0	| 50	| 100
	Insert next service with 'yes' response	| 0	| 50	| 100
	… continue to last service with 'yes' response	| 0	| 50	| 100
Free comments	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*			
Tip	Tip: Look up, down, left and right before going on			

Study strategies

Topic	**Questions**			
Explanatory text	This section asks about skills and strategies you use to manage your university studies. These are not services provided through the accessibility services, but things you do for yourself. Please continue when ready			
Study strategies used – lectures	Have you used any of these strategies for lectures or tutorials?			
	Printing slides before lectures	Yes ○	No but want to try it ○	No & won't try ○
	Sitting in a specific spot in lecture theatres	○	○	○
	Attending or viewing lectures multiple times	○	○	○
	Frequently pausing and replaying lecture videos	○	○	○
	Attending more than one tutorial group for the same subject	○	○	○
	Re-writing lecture notes using pictures and diagrams	○	○	○
	Have you used any other strategies for lectures or tutorials? If so, please specify: (Optional) *((Free text response field))*			

Study strategies used –reading ease	Have you ever used any of the following strategies to make reading easier?			
		Yes	No but want to try it	No & won't try
	Using a particular font	○	○	○
	Reading on a mobile phone	○	○	○
	Adjusting text into narrow columns	○	○	○
	Using a ruler or finger to keep your place on the page	○	○	○
	Beeline reader or other app to help track from line to line on screen	○	○	○
	Highlighting or underlining key words or phrases	○	○	○
	Circling or boxing key words or phrases	○	○	○
	If 'yes' to using a specific font: If you use a particular font, please specify which one: *((Free text response field))*			
	All respondents: Do you use any other strategies to make reading easier? If so, please specify: (Optional) *((Free text response field))*			
Study strategies used – reading comfort	Have you used any of these strategies to make reading more comfortable?			
		Yes	No but want to try it	No & won't try
	Reducing screen glare	○	○	○
	Reducing screen contrast	○	○	○
	Increasing light levels	○	○	○
	Decreasing light levels	○	○	○
Study strategies used – reading conditions	Have you used any of these strategies to adjust reading conditions?			
		Yes	No but want to try it	No & won't try
	Printing on coloured paper	○	○	○
	Coloured background on screens	○	○	○
	Using coloured overlays	○	○	○
	Wearing coloured glasses or contact lenses	○	○	○
	Have you used any other strategies to make reading more comfortable? If so, please specify: (Optional) *((Free text response field))*			

Study strategies used – reading substitution	Have you used any of these strategies instead of reading?			
		Yes	No but want to try it	No & won't try
	Watching videos instead of reading	○	○	○
	Audio books (other than Daisy books)	○	○	○
	C-pen or other text scanner	○	○	○
	Screen reading software you found or bought yourself	○	○	○
	Have you used any other strategies to replace reading? If so, please specify: (Optional) *((Free text response field))*			
Study strategies used – auditory	Have you used any of these strategies when reading?			
		Yes	No but want to try it	No & won't try
	Reading aloud to yourself	○	○	○
	Listening to soft music while reading	○	○	○
	Listening to loud music while reading	○	○	○
	Reading in a quiet place	○	○	○
	Reading in a place with low background noise	○	○	○
	Reading in a place with high background noise	○	○	○
	Have you used any other strategies to adjust your listening environment when reading? If so, please specify: (Optional) *((Free text response field))*			
Study strategies used – spelling and grammar	Do you use the following tools to help with spelling or grammar?			
		Yes	No but want to try it	No & won't try
	Spell checker built-in to Microsoft Word or similar	○	○	○
	Grammar checker built-in to Microsoft Word or similar	○	○	○
	Separate spell checking software	○	○	○
	Separate grammar checking software	○	○	○
	If 'yes' to separate spell checking or grammar checking software: What is the name of the spell checking or grammar checking software you use? *((Free text response field))*			

	All respondents: Have you used any other strategies to help with spelling and grammar? If so, please specify: (Optional) *((Free text response field))*	
Study strategy helpfulness – lectures	For any of the following strategies you have used, how helpful have you found them?	
	Printing slides before lectures	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*	
Study strategy helpfulness – reading ease	For any of the following strategies you have used, how helpful have you found them?	
	Using a particular font	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*	
Study strategy helpfulness – reading comfort and conditions (combined)	For any of the following strategies you have used, how helpful have you found them?	
	Reducing screen glare	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100

Study strategy helpfulness – reading substitution	For any of the following strategies you have used, how helpful have you found them?	
	Watching videos instead of reading	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*	
Study strategy helpfulness – auditory	For any of the following strategies you have used, how helpful have you found them?	
	Reading aloud to yourself	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*	
Study strategy helpfulness – spelling & grammar	For any of the following strategies you have used, how helpful have you found them?	
	Spell checker built in to Microsoft Word or similar	Not at all helpful — Somewhat helpful — Very helpful |——|——| 0 50 100
	Insert next strategy in this section with 'yes' response	|——|——| 0 50 100
	Continue to last strategy in section with 'yes' response	|——|——| 0 50 100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*	
Tip	Tip: You've nearly finished! Look around the room before going on.	

Teaching strategies

Explanatory text	This section will ask about techniques or strategies that your lecturers or tutors may have used that you may have found helpful for learning.			
Teaching strategies used – lecture slides	Have your lecturers or tutors used any of the following strategies related to lecture slides?			
		Yes	No but would like this	No & don't want
	Providing slides BEFORE lectures	○	○	○
	Providing slides AFTER lectures	○	○	○
	Placing text on half or less of each slide	○	○	○
	Using good font style and size on slides	○	○	○
	Using low-glare colours on slides	○	○	○
	Using diagrams or pictures in slides	○	○	○
	Have your lecturers or tutors used any other techniques or strategies that made their slides more helpful? If so, please specify: (Optional) *((Free text response field))*			
	Can you suggest any new or different ways lecturers or tutors could make their slides more helpful? If so, please specify: (Optional) *((Free text response field))*			
Teaching helpfulness – lecture slides	How helpful have you found these techniques related to lecture slides?			
		Not at all helpful	Somewhat helpful	Very helpful
	Insert first strategy with 'yes' response	|——|——| 0 50 100		
	Insert second strategy with 'yes' response	|——|——| 0 50 100		
	… and so on until last strategy with 'yes' response	|——|——| 0 50 100		
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*			
Teaching strategies used – style and organisation	Have your lecturers or tutors used any of these techniques related to their style and unit organisation?			
		Yes	No but would like this	No & don't want
	Speaking with an engaging style	○	○	○
	Drawing diagrams on a whiteboard	○	○	○

	Drawing diagrams using a paper projector	○	○	○
	Suggesting good videos about unit content	○	○	○
	Providing a printed course reader	○	○	○
	Setting smaller assessments more frequently	○	○	○
	Reviewing draft assignments and giving feedback	○	○	○
	Have your lecturers or tutors used any other style or organisation techniques that have been helpful? If so, please specify: (Optional) *((Free text response field))*			
	Can you suggest any new or different ways lecturers or tutors could make their style or unit organisation more helpful? If so, please specify: (Optional) *((Free text response field))*			
Teaching helpfulness – style and organisation	How helpful have you found the techniques and strategies your lecturers and tutors have used?			
	Insert first technique with 'yes' response	Not at all helpful 0	Somewhat helpful 50	Very helpful 100
	Insert second technique with 'yes' response	0	50	100
	… and so on until last technique with 'yes' response	0	50	100
	Would you like to comment about any of your ratings above? (Optional) *((Free text response field))*			

Other comments

Topic	**Questions**
Comments	Is there anything else you'd like to tell us about your reading or educational experiences? (Optional) *((Free text response field))*
Tip	Tip: All that's left now is the admin! Stretch quickly then continue.

Survey evaluation

Topic	Questions
Ease of completion	How easy or difficult was this survey to complete? Very easy Neutral Very difficult 0 50 100
Strengths	Was there anything you particularly liked about this survey? (Optional) *((Free text response field))*
Limitations	Was there anything particularly difficult about the survey? (Optional) *((Free text response field))*
Improvements	Could anything have made it easier? (Optional) *((Free text response field))*
Future research	Would you participate in this type of research in future if de-identified data is stored in the Open Science Framework? This is a community platform to increase accountability and replicability in science. **Please note:** This question is for our information only. No data from the current survey will be shared. Yes, I would participate if de-identified data were shared No, I would NOT participate if de-identified data were shared Not sure
Instruction text	**<<Click here>>** to go to a separate form to claim your gift card or research participation credits.

Remuneration and follow-up

Topic	Questions
Explanatory text	Note: Any email address and/or Student ID you provide will only be used to administer the requests below. They will not be linked to your survey answers or used for any other purpose
Compensation	Which of the following would you prefer to receive for your time? Electronic gift voucher for $15 Research participation credits for LING111 Research participation credits for SPHL299 *If gift voucher:* Please enter the email address you would like your gift voucher sent to: *((Free text response field))* *If research participation credits:* Please enter your Macquarie University Student ID number: *((Numeric field))*
Summary of findings	Would you like to receive a summary of this study's findings? (Optional) Yes / No *If 'yes':* Please enter the email address you would like a summary of the research findings sent to: *((Free text))*
More information	Would you like more information about strategies mentioned in this survey? (Optional) Yes / No *If 'yes':* Please enter the email address you would like information about strategies sent to: *((Free text field))*

APPENDIX 2: SURVEY QUESTIONS – Sections amended for students WITHOUT reading difficulties

You are invited to complete this survey

Introduction text – identical to version for students WITH reading difficulties

((Participant information as in-line text – version for students WITHOUT reading difficulties))

If you wish to download a copy of the participant information, click the document link below.

((Document link – version for students WITHOUT reading difficulties))

Participant eligibility and consent

((Eligibility and consent with tick-boxes – version for students WITHOUT reading difficulties))

Administrative information – identical to Appendix 1

Demographic information – identical to Appendix 1

Learning differences

Topic	Questions
Dyslexia assessment	First two questions retained (questions asked about formal assessment and/or self-identification of dyslexia or reading difficulty) The remainder of this section omitted and participants who answered 'yes' to either of the first two questions were re-directed to the version of the survey for students WITH Reading difficulties.
University disclosure	Section omitted
Other learning differences	Section identical
Tip	Identical

Reading experiences – identical to Appendix 1

Spelling experiences – identical to Appendix 1

Visual characteristics – identical to Appendix 1

Auditory characteristics – identical to Appendix 1

Education experiences – identical to Appendix 1

Accessibility services

Registration	Section omitted
Services wanted	Lists of accommodations identical to the other version 'Yes' choices omitted because students without a formal assessment of dyslexia would not be eligible to receive these accommodations from university accessibility services. **Choices for each:** Don't want to try it / Would like to try it
Service helpfulness	Section omitted because students WITHOUT reading difficulties can't access these services, so cannot reasonably evaluate their helpfulness
Tip	Identical

Study strategies – identical to Appendix 1

Teaching strategies – identical to Appendix 1

Other comments – identical to Appendix 1

Survey evaluation – identical to Appendix 1

Follow-up – identical to Appendix 1

APPENDIX 3: ETHICS APPROVAL LETTER

Human Sciences Subcommittee
Macquarie University, North Ryde
NSW 2109, Australia

MACQUARIE University

30/09/2019

Dear Dr Bosanquet,

Reference No: 52019578110468
Project ID: 5781
Title: Survey of strategies and services for dyslexic university students

Thank you for submitting the above application for ethical review. The Human Sciences Subcommittee has considered your application.

I am pleased to advise that ethical approval has been granted for this project to be conducted by Dr Agnes Bosanquet, and other personnel: Dr Nicholas Badcock, Ms Lois MacCullagh.

This research meets the requirements set out in the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018).

Standard Conditions of Approval:

1. Continuing compliance with the requirements of the National Statement, available from the following website: https://nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018.
2. This approval is valid for five (5) years, subject to the submission of annual reports. Please submit your reports on the anniversary of the approval for this protocol. You will be sent an automatic reminder email one week from the due date to remind you of your reporting responsibilities.
3. All adverse events, including unforeseen events, which might affect the continued ethical acceptability of the project, must be reported to the subcommittee within 72 hours.
4. All proposed changes to the project and associated documents must be submitted to the subcommittee for review and approval before implementation. Changes can be made via the Human Research Ethics Management System.

The HREC Terms of Reference and Standard Operating Procedures are available from the Research Services website: https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics.

It is the responsibility of the Chief Investigator to retain a copy of all documentation related to this project and to forward a copy of this approval letter to all personnel listed on the project.

Should you have any queries regarding your project, please contact the Faculty Ethics Officer.

The Human Sciences Subcommittee wishes you every success in your research.

Yours sincerely,

Dr Naomi Sweller

Chair, Human Sciences Subcommittee

The Faculty Ethics Subcommittees at Macquarie University operate in accordance with the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018), [Section 5.2.22].

Page 1 of 1

APPENDIX 4: QUANTITATIVE BETWEEN-GROUP ANALYSES OF AVERAGE HELPFULNESS RATINGS

Results of t-tests for group differences in average helpfulness ratings for 'Class' strategies

Pre-printing Slides: t(62) = 0.074, p = 0.941
Specific Location: t(41.607) = 1.449, p = 0.155
Lecture Reattendance: t(56) = -1.273, p = 0.208
Pause and Rewind: t(59) = -1.195, p = 0.237
Multiple Tutorials: t(36) = -0.903, p = 0.372
Diagram and Picture: t(60) = -1.626, p = 0.109

Results of t-tests for group differences in average helpfulness ratings for 'Visual Layout' strategies

Specific Font: t(25) = 0.828, p = 0.416
Reading on Phone: t(82) = 1.191, p = 0.237
Narrow Column: t(64) = 1.691, p = 0.096
Object Placeholder: t(71) = -0.637, p = 0.526
Line Tracker Software: t(36) = 0.562, p = 0.577
Highlight and Underline: t(89) = -0.698, p = 0.487
Circling: t(71) = -0.065, p = 0.948

Results of t-tests for group differences in average helpfulness ratings for 'Visual Environment' strategies

Reducing Glare: t(72.932) = 0.109, p = 0.913
Reducing Contrast: t(88) = 0.998, p = 0.321
Print Coloured Paper: t(50) = -0.630, p = 0.532
Coloured Background: t(56) = -0.242, p = 0.810
Coloured Overlay: t(39) = -0.557, p = 0.580
Coloured Glasses: t(26) = -0.854, p = 0.401

Results of t-tests for group differences in average helpfulness ratings for 'Reading Substitution' strategies

Video Substitution: t(79) = -0.636, p = 0.527
Audiobooks: t(64) = 0.719, p = 0.475
Text Scanner Personal: t(10.223) = 1.679, p = 0.123
Screen Reader Personal: t(51) = 0.217, p = 0.829

Results of t-tests for group differences in average helpfulness ratings for 'Auditory' strategies

Reading Aloud: t(77) = -2.238, p = 0.028
Soft Music: t(77) = 0.216, p = 0.830
Loud Music: t(28) = 1.249, p = 0.222
Quiet Space: t(97) = -2.491, p = 0.014
Low Background Noise: t(80) = -.885, p = 0.379
High Background Noise: t(23) = 1.835, p = 0.079

Results of t-tests for group differences in average helpfulness ratings for 'Spelling & Grammar' strategies

Packaged Spell Checker: t(60.961) = -1.739, p = 0.087
Packaged Grammar Check: t(22) = -0.430, p = 0.671
Separate Spell Checker: t(68) = -1.705, p = 0.093
Separate Grammar Check: t(15.010) = 0.340, p = 0.739

APPENDIX 5: FULL QUALITATIVE DATASET ON PERCEIVED HELPFULNESS RATINGS

Comments on perceived helpfulness of 'Class' strategies

D-A participant comments:

"Sitting in the right spot where you can see and hear in the lecture I find makes it easier"

"Fit me"

"I feel comfortable when I know my environment, sitting in the same spot helps to stay calm. Also your lecturer may remember you."

"I would not be able to get through the lectures with out being able to see the slides in front of me, I also need to the records to catch up sections of notes that I missed as I was trying finished the notes from previous sections."

ND participant comments:

"Rewatching lecture videos multiple times is the most helpful strategy that I have used."

"I really dislike listening to or attending a lecture without the lecture notes printed out onto paper for me to directly write on"

"Viewing lecture multiple times, and constantly pausing and replaying lecture helps me make sure I have taken down all necessary information and not missed and key points. Re-writing lecture notes helps me understand what is being said in my own manner and allows me to have complete control over how I study and learn the information."

"I find that when I attend uni and my classes and am up to date, this improves my reading skills as I am constantly engaging in study. When I don't attend uni or am not up to date, this slows my reading and study time as I have to spend more time trying to understand what is happening."

"Pausing and replaying allows you to write important things down and being able to go over them again if you don't interpret them correctly the first time. And pictures and diagrams allow me to visually remember information."

"Because I sometimes end up highlighting too many words/phrases, I find that putting a box around them or drawing a picture next to it brings my attention to it a bit more."

"I think it is imperative to pause and replay lectures because you miss out on so much as the lectures go very quickly."

"Sitting in a specific location is dependent on the environment (e.g. clarity and loudness of the lecturer). Rewriting lecture notes as diagrams is dependent on the material being studied. As such I've left these ratings as 50 to reflect that they are sometimes useful, but not universally useful (for me)."

Comments on perceived helpfulness of 'Visual Layout' strategies

D-A participant comments:

"Highlighting and using brackets for reading makes it easier to follow."

"I can make the font bigger, my finger keeps my spot and the colours of the highlighter helps me pick up a thought."

ND participant comments:

" One colour for headings, one for keywords and another for examples."

" Using colours on the page makes it more appealing to learn."

" Doing these things actually help me read better as I can focus more on the text and not be distracted by other things."

" Highlighting allows me to pick out key aspects of texts, while using a finger ruler makes the reading processes easier and quicker."

" I personally find sans-serif fonts to aid readability, which is why I prefer Arial. I read on my mobile phone more out of necessity than preference (hence the 50). Keeping my place with a finger or other object is useful when I am simultaneously writing (e.g. notes), and circling key words or phrases is useful when the reading is done over multiple sittings, or when I know I will need to revisit the material/document."

Comments on perceived helpfulness of 'Visual Environment' strategies

D-A participant comments:

"Using coloured paper is just as hard as white I find it better if it is broken e.g. blue all around and a white or yellow bar for the line I am working on."

"Easy to see"

"I like the coloured however not found anyone willing to fill my prescriptions in a red lens."

ND participant comments:

"Depending on whether it's during the day or night they help from hurting my eyes."

"Wearing coloured glasses makes reading much easier for me, and reducing glare also allows me to look at my screen for longer and thus be more productive."

"Helps to reduce eye strain"

"Reducing glare and changing background colour is useful depending on existing lighting conditions, such as if there is too much glare I will try to reduce it. I find my glasses are useful in reducing eye strain over long sessions, but I don't need them to see and so I'm often lazy and wont' wear them (until the eye strain kicks in)."

Comments on perceived helpfulness of 'Reading Substitution' strategies

D-A participant comments:

"[Listening] to books is so much easier than reading them."

"Podcasts are also extremely helpful."

"Easy to understand"

"As long as they have voices along with the video"

"I'm very practical so if I see something done and then follow it being done it seems to help me understand it the most."

ND participant comments:

"A lot of times I better understand thing when it is explained to me verbally and demonstrated rather than reading it."

"I am more of a visual learner than an audio learner."

"Audio books I find I zone out and have to keep going back for information. But videos I absorb information and remember things from a visual aspect."

"Videos are often more engaging and makes me enjoy learning more than if I was just reading about something. They are also shorter and can be more efficient."

"If I have a choice between watching a video or reading the same material, I'll often choose the latter."

Comments on perceived helpfulness of 'Auditory' strategies

D-A participant comments:

"Less sound is a bit easier while reading."

"Steel oneself."

"If it's too quiet I get more distracted."

"Reading in the quiet place usually means I get sleepy and I feel isolated."

ND participant comments:

"Reading in a quiet place or with low background noise is essentially the same in how helpful, but loud background noise is very disruptive when you're trying to read."

"Reading aloud sometimes helps me memorise info better, and with little background noise and reading in a quiet place I am not distracted by anything around me."

"I need to be in a silent or semi-quiet place for me to properly focus and read and understand."

"If I'm not in a quiet place I cannot concentrate and can get distracted."

"I find some amount of background noise helpful in most situations, unless I'm reading something that requires a lot of thinking (e.g. technical information)."

Comments on perceived helpfulness of 'Spelling & Grammar' strategies

D-A participant comments:

"Having a couple of grammar apps just to make sure I have spelled the words right."

"Learning helps"

"Sometimes it is American!"

"Life saver!!"

"In a way, the spell checker and grammar checker which are built-in to Microsoft Word, are actually quite unhelpful to me because I get so used to it just automatically correcting my mis-spelt words, that I do not actually make the conscious effort to spell the words correctly. Therefore, when it comes to writing in conditions where I do not have a spell checker, I find that I am making many mistakes. Then again, when it comes to essay writing and important documents, I am very thankful for spell check."

ND participant comments:

"Helps making sure everything correct because when typing fast I unintentionally spell or write things wrong."