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How do adults with neurodevelopmental disorders prefer information being presented?

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ABSTRACT

Neurodiverse children do not always benefit from a typical learning environment and therefore may be at a disadvantage when learning alongside their peers. Many of these children have different preferences when it comes to the formatting of learning materials, which may impact their performance. The current study examined the preferences of 204 adults with diagnosed ADHD, autism, dyslexia, dyscalculia, and dyspraxia to identify formatting preferences for formatting variables previously shown to influence performance: font style, font size, character spacing, line spacing, title design, background colour, reward icon and instruction layout. Preferences were obtained by means of a survey, where participants rated their preferences on 5-point, Likert-type scales (1 = strongly disagree to 5 = strongly agree). Participants were also asked to rank the options provided for each formatting variable from least favourite to favourite. Results indicated consistent preference across all neurodiverse groups, with one category in each being significantly preferred across all groups. The exception to this was background colour, in which each neurodiverse group preferred a different colour.

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Learning; neurodiversities; learning materials

Introduction

Neurodevelopmental disorders (NDD) have become increasingly acknowledged and understood in recent years, resulting in higher rates of diagnoses (Yang et al., 2022). An NDD refers to a type of disorder where the brain's development has been affected, and therefore prevents individuals from reaching recognised cognitive, emotional, and motor developmental milestones (Parenti et al., 2020). The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association [APA], 2013) defines NDDs as a group of conditions characterised by developmental deficits that impair personal, social, academic, or occupational functioning (Valentine et al., 2020). Some of

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the most common NDDs include attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and learning difficulties such as dyslexia, dyscalculia, and dyspraxia. The estimated prevalence of these NDDs in the global population is as follows: (i) dyslexia: 9–12% (European Dyslexia Association, 2022); (ii) dyscalculia: 3–7% (Haberstroh & Schulte-Körne, 2019); (iii) dyspraxia: 5–6% (Pedro & Goldschmidt, 2019); (iv) ADHD: 2–7% (Song et al., 2021); (v) ASD: 1 in 100 children (World Health Organisation, 2023). An interesting characteristic of NDDs is the co-occurrence of two or more different disorders, or comorbidity, which represent the norm rather than an exception (Francés et al., 2022).

The United Nations' Convention of the Rights of People with Disability affirms the need to provide "reasonable accommodations", which is defined as the "necessary and appropriate modification and adjustments not imposing a disproportionate or undue burden, where needed in a particular case, to ensure to persons with disabilities the enjoyment or exercise on an equal basis with others of all human rights and fundamental freedoms to support their learning development" (United Nations, 2006). Researchers have called for a clearer definition of shared guidelines and raised concerns over a lack of consideration of NDDs during the design of digital learning materials (Petretto et al., 2021). With Prior (1996) finding that at least one in every ten school-aged children have difficulties in one or more areas of their school curriculum, most commonly in reading and spelling, this paper aims to build a better understanding of the necessary accommodations that should be provided to increase digital text legibility for the most common NDDs: dyslexia, dyscalculia, dyspraxia, ASD, and ADHD.

Dyslexia

Pennington and Peterson (2015) suggest that an expert spends many years mastering key basic skills in their domain before being able to apply them in a creative way in combination with higher level thinking skills. To illustrate, just as a guitarist cannot become an expert without learning the basic chords, a child cannot develop complex academic skills such as reading, written comprehension or mathematical problem-solving without developing automaticity in basic academic skills such as single-word processing, handwriting, spelling, and lexical recognition of mathematical symbols or numerical figures. However, despite substantial practice, some individuals vary in the extent to which they develop this automaticity, resulting in limited cognitive capacity to devote to higher-level thinking (Perfetti, 1998). This "resource allocation hypothesis" postulated by Perfetti (1998) holds that due to the limited cognitive resources available, performance in a given complex skill depends on the level of cognitive resources that one must spend on basic skills that are not yet automatic. This suggests that a child with dyslexia who struggles with single-word reading may perform poorly in reading comprehension due to the higher cognitive load placed on basic skills such as decoding, rather than the complex task of analysing text.

Dyslexia is well-known for being a reading deficit; however, there are many theories regarding underlying causes. First, neuroimaging research suggests that the process of reading is carried out by multiple components of the brain. A deficit in any part of this processing system would lead to impaired reading ability, and therefore may be a contributing factor to dyslexia (Backes et al., 2002; Beneventi et al., 2010; Norton et al., 2015). To support this, Beneventi et al. (2010) and Snowling et al. (2000) indicated that dyslexic individuals suffer from poor working memory, specifically verbal short term, phonological awareness, and visuospatial working memory. Therefore, it is predicted that in a classroom setting, dyslexic individuals would have difficulty listening to and/or reading long task instructions and would struggle in the absence of visual aids. Since there is evidence that individuals with dyslexia may be slightly better at listening than reading (Košak-Babuder et al., 2019), the option of having a task read out verbally may be beneficial in an educational setting. However, though dyslexia is commonly considered a reading impairment, phonological deficits are also evident in many cases; therefore, listening tasks may not always be beneficial (Stevens et al., 2022; Ziegler et al., 2008). Individual needs would need to be taken into account when developing the education strategy for a dyslexic student.

Dyscalculia

Dyscalculia is a NDD that involves a significant difficulty in numerical processing despite normal intellectual abilities and education (Government Office for Science, 2020). People with dyscalculia struggle with comprehending and solving mathematical concepts (Rohizan et al., 2020). Typical symptoms include difficulties understanding the notion of biggest versus smallest, relating numerical figures to their words (e.g., “5” to “five”), recognising or applying mathematical symbols and concepts, and performing mental operations. Assistive technologies such as talking calculators, electronic worksheets, and digital graph paper have been effectively utilised to support learners with dyscalculia (Rohizan et al., 2020).

Dyspraxia

The APA (2013) characterises dyspraxia as the inability to acquire and execute coordinated motor skills that are expected for their chronological age. Several labels exist for this disorder, including developmental coordination disorder, a disorder of sensory integration, and the “Clumsy Child Syndrome” (Gubbay, 1978; Pedro & Goldschmidt, 2019). Although this affects around 5% of school-aged children, the prevalence of this disorder could be higher than current estimates, due to the lack of awareness and diagnosis (Pedro & Goldschmidt, 2019). Dyspraxia is the result of disruption in the neuronal pathway between the brain and the body, although it is not yet known what causes this disruption. It is thought to be due to immature neuronal development rather than brain damage, illness, or injury (Dyspraxia Foundation, n.d.). Other research has also called it developmental coordination disorder with an ongoing debate as to whether this is a medical or social disorder (Gibbs et al., 2007).

People with dyspraxia may experience motor difficulties including poor balance, coordination, and spatial awareness, which can make it difficult to carry out day-to-day activities such as crawling, walking, riding a bicycle, and self-care activities such as dressing and feeding (Pedro & Goldschmidt, 2019). Children with dyspraxia may encounter challenges at school with regards to writing, cutting and other artwork, completing tasks on time, and playing sports. In addition, research has shown that children with learning disorders, such as dyspraxia, are more likely to be bullied at school and have low self-esteem. With handwriting being an essential skill in formal school settings, a pupil who is visibly struggling with this skill compared to their peers may avoid handwriting and harbour feelings of failure, resulting in lower self-esteem and potential behaviour difficulties (Boyle, 2007).

ASD

ASD is a NDD characterised by impairment in communication and social interaction (APA, 2013). Every person with ASD is different, hence the term, "spectrum disorder" (Dattolo & Luccio, 2017). While not everyone with ASD will experience difficulties in reading comprehension, many will struggle with a range of linguistic skills (Yaneva, 2016). Echolalia, the compulsive repeating of a word or phrase, and fixation on a particular cognitive pattern or in local features rather than global coherence are typical of ASD, as well as challenges in understanding intonation or body language (Bennie, 2022). ASD affects an estimated 700,000 people in the UK, including 1 in 100 children and approximately 1.1% of adults (National Autistic Society, 2025). The UK has implemented several key policies and legal frameworks to support autistic individuals, particularly in employment and digital accessibility. The Autism Act 2009 mandates a national autism strategy for adults, expanded in 2021 to include children and young people for the first time. Under the Equality Act 2010, autistic individuals are protected from discrimination and entitled to reasonable adjustments and access to work grants (National Autistic Society, 2025). The UK's Equality Act 2010 and Public Sector Bodies Accessibility Regulations 2018 enforce digital accessibility standards comparable to the American Disability Act. Specific requirements can include text alternatives for non-text content, captions for videos, compatibility with screen readers, and responsive design for varying font sizes. Lower scores in reading comprehension in children with ASD are often seen for their level of reading ability. This is even the case for children with ASD and hyperlexia, which is characterised by skills higher in word recognition than in reading comprehension. These difficulties are not likely due to deficits in word decoding skills (Huemer & Mann, 2010). Reading comprehension is defined as the ability to derive meaning from passages of written language (National Early Literacy Panel, 2008), whereas reading ability refers to the ability to decode words using a phonological and/or an orthographic approach (Macdonald et al., 2021).

There seems to be a dissociation between decoding and comprehension, which may be due to difficulties interpreting ambiguities, and understanding context and figurative language Huemer and Mann (2010). These findings indicate the dissociation of form (language structure) and function (language use). However, Nation et al. (2006) through analysing 41 children on a variety of reading accuracy and reading comprehension tasks points to the possibility of poor decoding skills as one of the factors behind difficulties in reading comprehension for some people with ASD. Yaneva (2016) calls for further exploration of the factors affecting text legibility such as font sizes, font types, line spacing, and background colours. In addition, they added extra-textual strategies for supporting comprehension and memorisation such as the emphasis of key words and presentation of text in bullet-point form, all of which enhance accessibility.

ADHD

There has been much literature on the educational challenges of individuals with ADHD. Such research has identified difficulties with inhibition control, deficits in sustained and selective attention, and executive functioning deficits (Barkley, 1997; Marchetta et al., 2007; Tucha et al., 2015). Damaged inhibition implies that individuals with ADHD will struggle to suppress responses, whether they be cognitive, emotional, or behavioural (Coutinho et al., 2018). Therefore, in an educational setting, they may have difficulty completing tasks if more than one is presented at a time. This may also occur due to attentional deficits, another symptom of ADHD. Literature has indicated damage to attentional pathways in ADHD, which suggests these individuals may struggle to stay focused (sustained attention) and get easily distracted (selective attention) (Marchetta et al., 2007; Tucha et al., 2015). Therefore, in a classroom setting, these individuals would likely struggle with tasks that extend for long periods of time, or complex tasks that require multiple steps, as well as staying on task in the presence of external distractors. Other research has demonstrated that working memory and other executive functioning may be impaired, which includes tasks such as reading and listening (Berlin et al., 2004). This suggests that visual aids are very important in an educational setting, along with repetition and tasks/instructions that are broken down into smaller steps. Interestingly, it has been seen that ADHD individuals respond very well to social rewards (Kohls et al., 2009). Therefore, social rewards may be an important aspect in the classroom in epitomising the learning environment for an individual with ADHD. The investigation of external social rewards are out of the scope of this study, but the need to research the impact of this is recognised. There is little literature on the effects of certain font types, styles, or colours on learning in ADHD, although there is some literature to suggest that ADHD individuals may have a deficit in the blue-yellow colour pathway (Banaschewski et al., 2006).

Although there has been some research into dyslexia and accessibility of digital text, little is known about the impact of other disorders such as ADHD and ASD (Banaschewski et al., 2006; Yaneva, 2016). Even within the dyslexia domain, conflicting research findings impede the development of established guidelines, where none of the proposed solutions can be considered definite for all individuals with dyslexia, across different situations (Rello, 2015). Moreover, the limited number of studies specifically dedicated to factors such as font size and font style is not comparable, nor incremental, and often non-complementary. Addressing this issue is out of the scope of this paper, but instead we aim to provide a brief overview of the common NDDs (ADHD, ASD, and DDD), and their preferences for the presentation of digital text to support educators, researchers, designers, and any other interested parties to improve digital text readability.

Present study

This research has identified the problem that neurodiverse learners have difficulty with information presented in certain formats. The aim of this study, therefore, was to determine what types of formatting and presentation are preferred or not preferred by individuals with different neurodiversity, in an effort to help aid more effective presentation of information for learning in neurodiversity. This is motivated by the goal of designing educational tools that work best for neurodevelopmental disorders. The specific neurodevelopmental disorders we have chosen to pursue are: ADHD, Autism, Dyslexia, Dyscalculia, and Dyspraxia. The stimuli we have chosen to test are features that developers or users are most commonly able to manipulate: font size, font colour, font type, line spacing, background colour, presentation of instructions, presentation of title and types of rewards. Therefore, the study has the following hypotheses:

H1: Font size 14 is the main preference font size compared to font size 12 and 16.

H2: Open dyslexia is the preferred font type compared to Arial and Courier New.

H3: Double line spacing is preferred to single line spacing and 1.5 line spacing.

H4: Favourite background colour is blue as compared to white, yellow, and grey.

H5: Instructions are preferred to be presented as bullet points compared to paragraphs or each instruction in a new page.

H6: Bold title compared to italics or underlined title is presented is the preferred way of presenting information.

H7: Rewards are positively received. In particular for participants with ADHD, it is predicted that a social reward is perceived better than other rewards.

Method

Participants

A total of 400 individuals started the survey. However, after cleaning the data only 204 participants met the criteria (finished the survey, were a UK resident, gave consent, were older than 16 years and were diagnosed with a developmental disorder). In terms of age, 26.0% ($n = 53$) of participants were between 16 and 24 years old; 38.2% ($n = 78$) were between 25 and 35 years old; 17.2% ($n = 35$) were between 36 and 45 years old and 18.6% ($n = 38$) were between 46 and 60 years old. In relation to the developmental disorder(s) they were diagnosed with, 37.3% ($n = 76$) of participants were diagnosed with ADHD; 33.3% ($n = 68$) were diagnosed with autism spectrum disorder; 29.4% ($n = 60$) were diagnosed with either dyslexia, dyscalculia, dyspraxia, or a combination of these, which have been grouped together as the "DDD" group due to similarities in cognitive processing difficulties (classified as "specific learning difficulties" in DSM-5), whereas ADHD and ASD have distinct neurobiological underpinnings and their own well-established criteria and classification systems, which differentiate them from dyslexia, dyscalculia, and dyspraxia (APA, 2013). Research estimates show a high prevalence of comorbidity among individuals diagnosed with NDDs. Studies have found comorbidity rates of 50–70% for people with ASD and ADHD (Hours et al., 2022), 40% for dyslexia and dyscalculia (Wilson et al., 2015), and 50% for dyspraxia and ADHD (APA, 2013). However, the number of respondents with comorbidities was much lower than these estimates, preventing a sufficient sample size for statistical analysis. In addition, our method did not allow us to determine which NDD diagnosis was responsible for any variance measured, leading to a decision to ignore comorbidities for the purposes of this study. In addition, some of the comorbidities had a very small sample size, limiting any statistical analyses.

Materials

Participants were asked to complete a number of sections via an online survey. This particular design was chosen to mimic a diagnostic assessment in the online space. The stimuli were chosen to not just measure perception and opinions on the way the participants read, but to let the participant experience these different varieties of the way words can be formatted. This allowed them to give ratings based on the ease of reading with the actual stimuli, rather than estimating their preferences.

Section 1

In this section, participants were asked to rate how easy a sentence was to read for them. Each sentence had one of the following variables changed: font size, font style, spacing between characters, spacing between lines, and background colour. Each item was scored on a 5-point, Likert-type scale (1 = strongly disagree, 5 = strongly agree), so that higher scores reflected that the sentence was easy to read. Participants were also asked to rank the sentences from least favourite to favourite per variable.

Section 2

Participants were presented with example instructions and were asked to select the response that most accurately represented their opinion of the layout of the instructions. Each item was scored on a 5-point, Likert-type scale (1 = strongly disagree, 5 = strongly agree), so that higher scores reflected that the instructions were easier to read. The instructions were given in bullet points, with one instruction given on each page; or the instructions were given in one single paragraph.

Section 3

Participants were presented with some example titles and had to rate how much the title in the example was distinctive from the main text. Each item was scored on a 5-point, Likert-type scale (1 = strongly disagree, 5 = strongly agree), so that higher scores reflected that the title was distinctive from the main text. The titles were presented using different combinations of bold, italics, and underlined.

Section 4

Participants were presented with different icons for collecting rewards and were asked to rate to what extent they would enjoy collecting rewards using those icons. Each item was scored on a 5-point, Likert-type scale (1 = strongly disagree, 5 = strongly agree), so that higher scores reflected that the icon was very enjoyable.

Procedure

The inclusion criteria were that participants must have a developmental disorder such as dyslexia, dyscalculia, dyspraxia, ADHD, or autism spectrum disorder, must be over the age of 16, and a resident in the UK. Participants were recruited between the 1 March 2022 and the 1 September 2022 primarily via social media (i.e., LinkedIn, X) from a convenience sample. Prior to conducting the study, the authors obtained ethics approval from the institution (Ref: 001-MAR2022). Data were collected using Qualtrics. First, participants read the participant information sheet that explained the purpose of the study in general terms followed by reading and signing an informed consent sheet to provide consent to take part in the study. Second, participants completed the survey consisting of the aforementioned measures. Finally, participants read a debriefing form that explained the purpose of the study in detail. Participation was strictly voluntary.

Results

Each of the NDDs was initially analysed separately for each variable: (i) ADHD; (ii) ASD; and (iii) DDD (dyslexia-family).

Font size

Chi-square test was used to determine if there is a statistically significant relationship between categorical variables. A chi-square test showed no significant difference in the preference of the type of font size used in the sentence $X^2(2, 204) = 2.26$, $p = .30$, $V = .11$. Font size 16 was the most preferred font size for all groups in the rankings: (i) ADHD – 60.5%; (ii) ASD – 64.7%; and (iii) DDD – 73.3% (Figure 1). The Likert scale also demonstrated that font size 16 was the easiest to read for most participants, regardless of their ranking for preference (see Appendix A).

Font style

A chi-square test showed that there was no significant difference in the preference of font style used in the sentence $X^2(2, 204) = 1.71$, $p = .42$, $V = .09$. The font type Arial was the most preferred font type for all groups in the rankings: (i) ADHD – 78.9%; (ii) ASD – 83.8%; and (iii) DDD – 85.0% (Figure 2). Arial was the font style that was the easiest to read for most participants, regardless of their ranking for preference. This was quite surprising as Open Dyslexia was not preferred at all by participants (see Appendix B).

Line spacing

A chi-square test found that participants from all three groups did not significantly differ on their preference for line spacing $X^2(4, 204) = 1.71$, $p = .42$, $V = .09$. Single-spaced was the most preferred from all groups in the rankings: (i) ADHD – 78.9%; (ii) ASD – 60.3%; and (iii) DDD – 45.0% (Figure 3). However, most DDD participants (81.6%) agreed x1.5 line spacing is easy to read, whereas single-spaced only received 68% of the votes. The ADHD group showed a similar trend in the proportion of participants (81.5%) that agreed single-spaced or x1.5 line spacing were easy to read (see Appendix C).

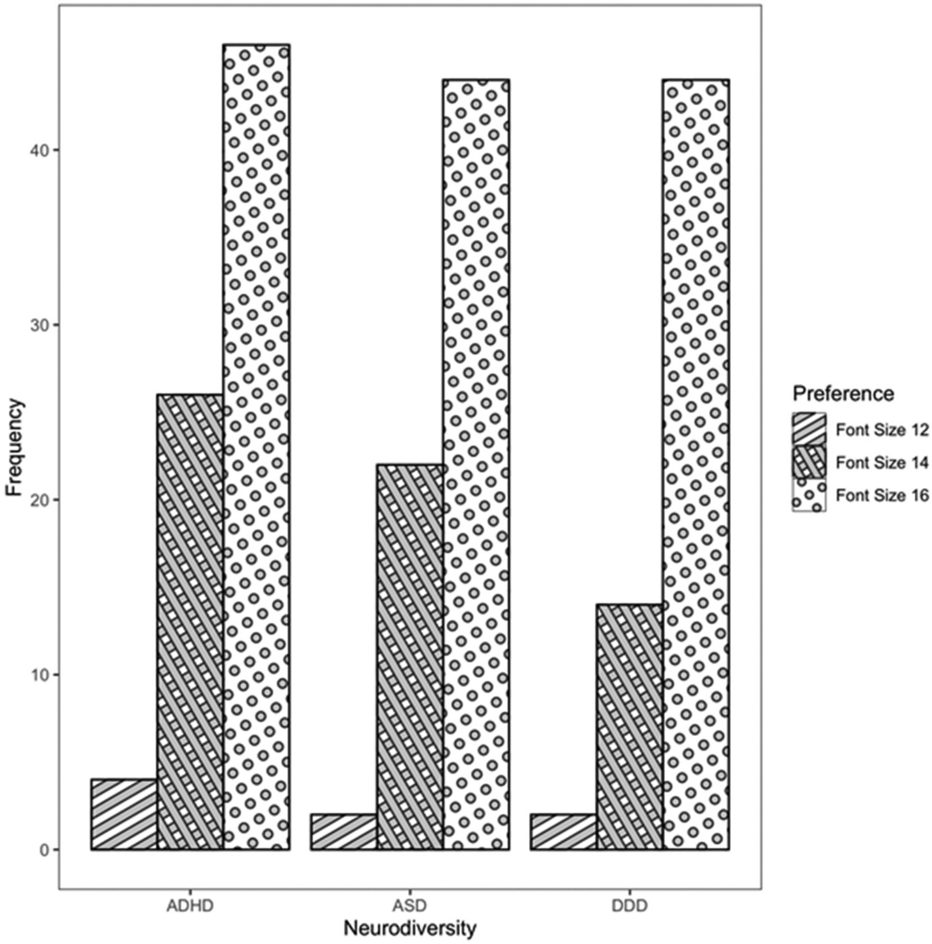

Figure 1. Pearson's chi-square test for font size.

Instruction style

A chi-square test showed that there was a significant difference in the preference of the style of instruction $X^2(2, 204) = 8.45$, $p = .01$, $V = .21$. The bullet-point style received the most votes for all groups in the rankings: (i) ADHD – 69.7%; (ii) ASD – 83.8%; and (iii) DDD – 85% (Figure 4). The Likert scale also demonstrated that the bullet-point style of instruction was the easiest to read for most participants, regardless of their ranking for preference (see Appendix D).

Background colour

A chi-square test demonstrated a significant difference in group preference for the different background colours $X^2(4, 204) = 9.73$, $p = .04$, $V = .17$. Interestingly, each neurodiverse group (ADHD, ASD, and DDD) significantly preferred a different colour

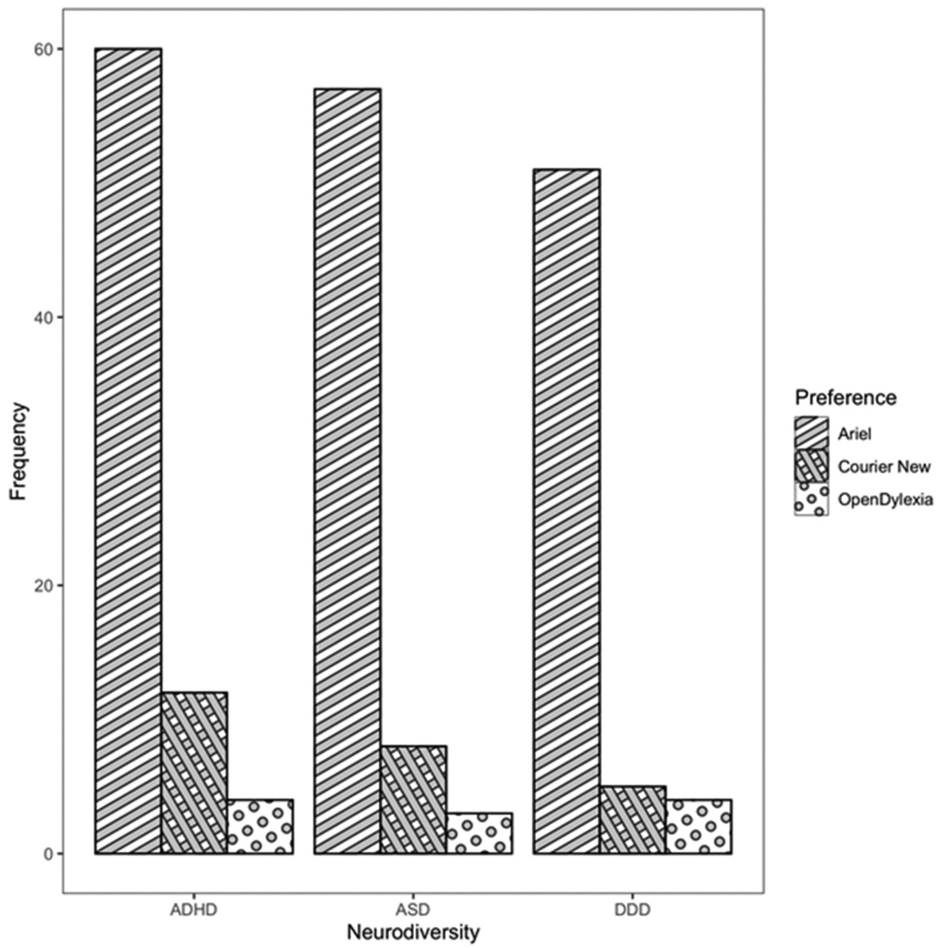

Figure 2. Pearson's chi-square test for font style.

in the ranking question, as shown in Figure 5: ADHD preferred blue (34.2% of participants), ASD preferred white (38.2% of participants) and DDD preferred yellow (41.7% of participants). The Likert scale generated similar results with blue receiving the most amount of votes for being easy to read for all groups.

Rewards

A chi-square test demonstrated that there was not a significant difference in group preference for the reward type $X^2(8, 204) = 3.53$, $p = .83$, $V = .09$ (Figure 6). The gold coin (Type 1) received the most votes for all groups in the ranking: ADHD (50%), ASD (50%), and DDD (46.7%). The Likert-scale rating showed similar results where the gold coin received the highest number of votes for being the most preferred in all five presented options: (i) Type 1 – gold coin; (ii) Type 2 – gold trophy; (iii) Type 3 – giftbox; (iv) Type 4 – gold badge; (v) Type 5 – treasure chest.

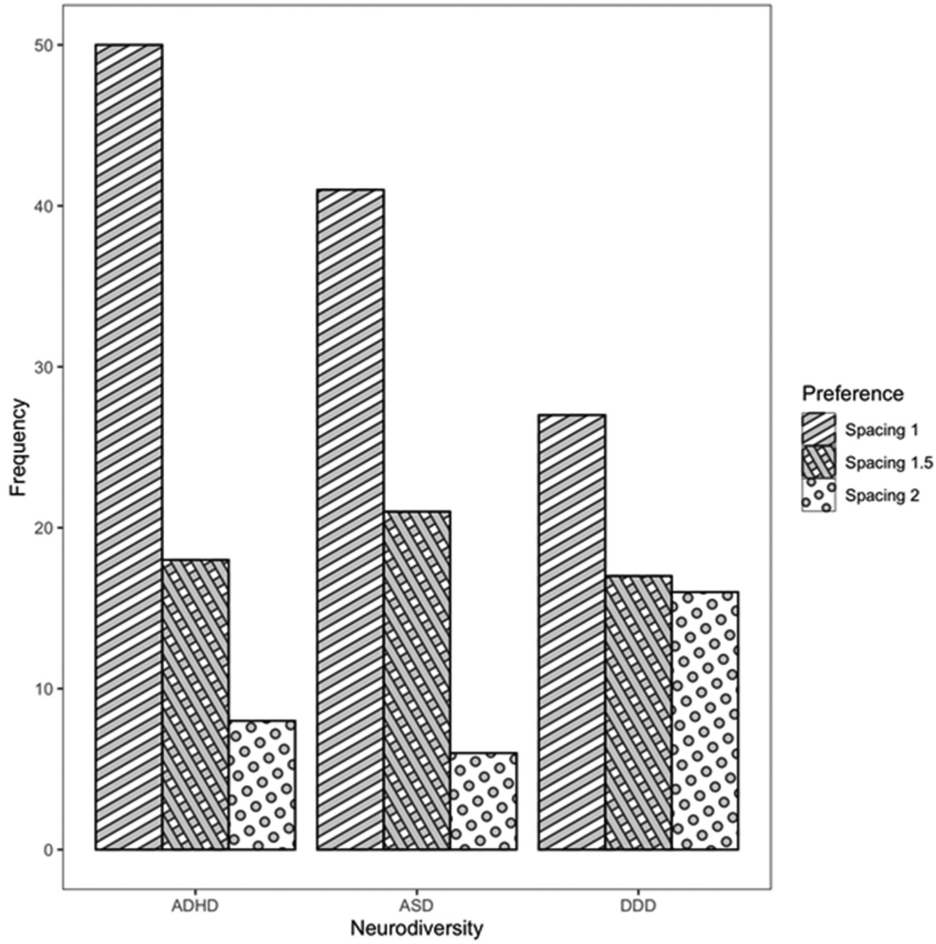

Figure 3. Pearson's chi-square test for line spacing.

Title format

A chi-square test demonstrated that participants from all three groups did not significantly differ on their preference for title format $X^2(6, 204) = 6.24$, $p = .39$, $V = .13$ (Figure 7). Bold style received the most votes for all groups in the ranking: ADHD (44.7%), ASD (32.4%), and DDD (48.3%). However, in the Likert scale, whilst DDD still showed a preference for bold (81.3%), the underlined option received the highest number of "easy to read" votes from both ASD (50%) and ADHD (58%) groups.

Discussion

ADHD

Other than one tested variable, title layout, ADHD participants were consistent with their voting of "favourite design" between the Likert question and the ranking. With font size, ADHD participants' highest ranked option, size 16, was consistent with the other

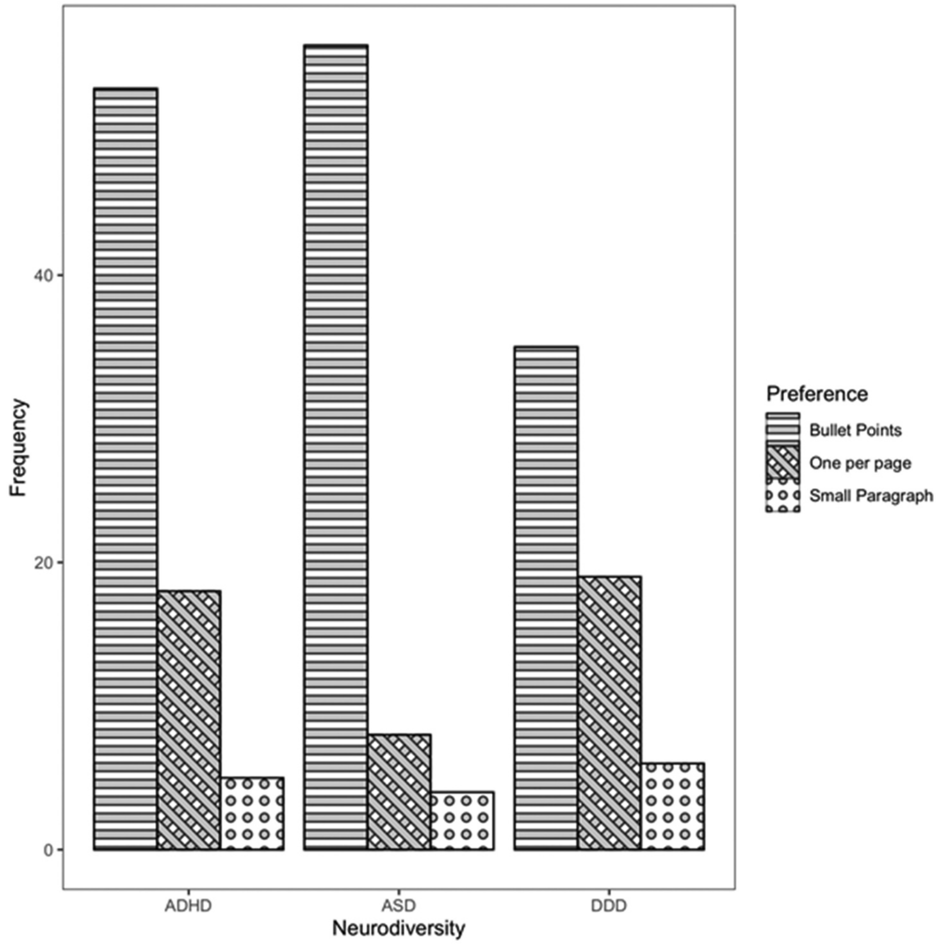

Figure 4. Pearson's chi-square test for instruction style.

neurodiverse groups. This consistency was the same for font style (Arial), line spacing (1 line), instruction layout (bullet points), title layout (bold) and reward design (reward 1). A few of these results are interesting when compared to some of the literature. Banaschewski et al. (2006) indicated a possible deficit in the blue-yellow colour pathways in individuals with ADHD, therefore it is interesting that the blue background was the favourite as this is contradicting previous findings. Though this deficit is more evident under timed conditions, it is still a controversial result. Another unexpected result was that of font style. Though there is little to no literature on font style and its effect on ADHD individuals, an article by "Full Fabric" suggested that mono-spaced fonts are more favoured by neurodiverse readers due to less confusion between the letters, and therefore implies "courier new" should have be the favourite font in the current study rather than "arial" (Brown, 2023). However, they also looked at font style in non-neurodiverse individuals and found both Arial and Courier to be most easily read, with arial slightly superior. It may be that there is not a consistent effect of font style on ADHD readers, and therefore Arial is the general preferred font style regardless of the NDD. With regard to the line

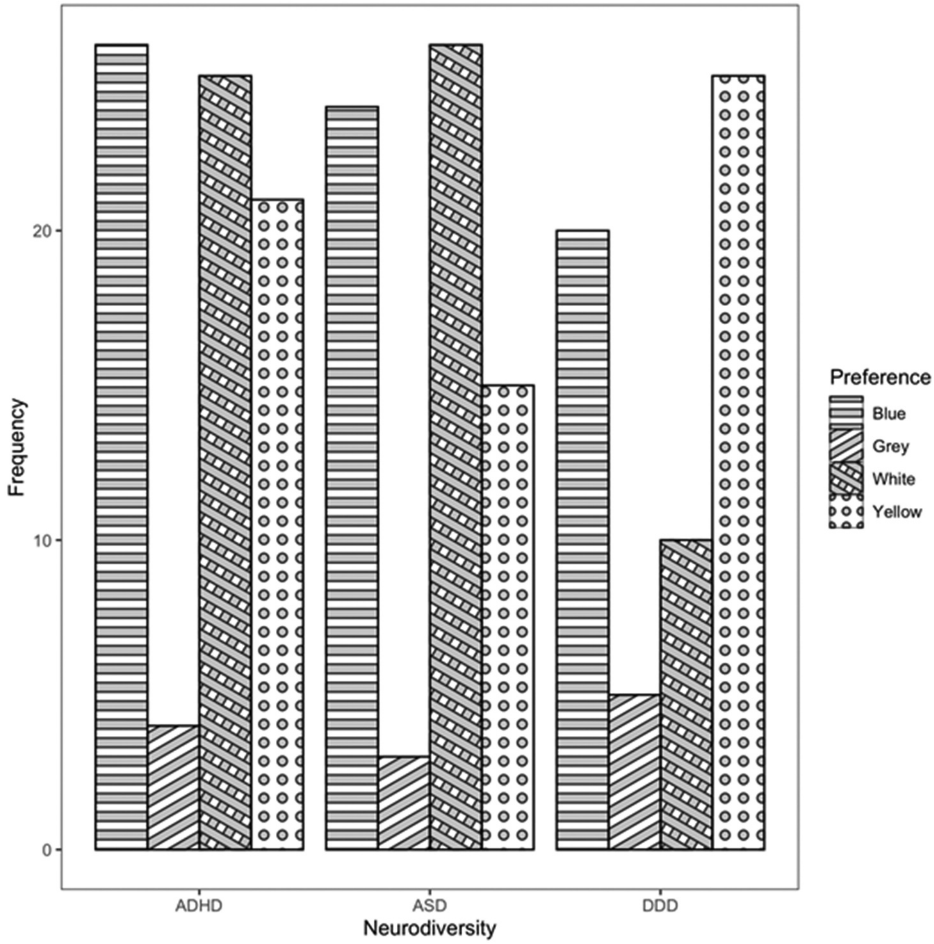

Figure 5. Pearson's chi-square test for background colour.

spacing, though there is not much literature to suggest a direction, a smaller line spacing may create a crowding effect (Perea et al., 2012), which may indicate why the smaller line spacing was preferred. Finally, another area of interest was the reward icon. As mentioned previously, there is evidence to suggest ADHD individuals respond well to social rewards (Kohls et al., 2009). In this study, however, it was the monetary reward that was much preferred.

ASD

People with ASD experience difficulties in the pragmatic components of communication such as inability to understand context, figurative language, ambiguity, humour, and sarcasm, rather than a deficit in word decoding skills (Yaneva, 2016). In fact, ASD is the most common NDD associated with hyperlexia, which is characterised by higher skills in word recognition than in reading comprehension and general verbal functioning (Macdonald et al., 2021). As such, research has mostly focused on improving the ease of

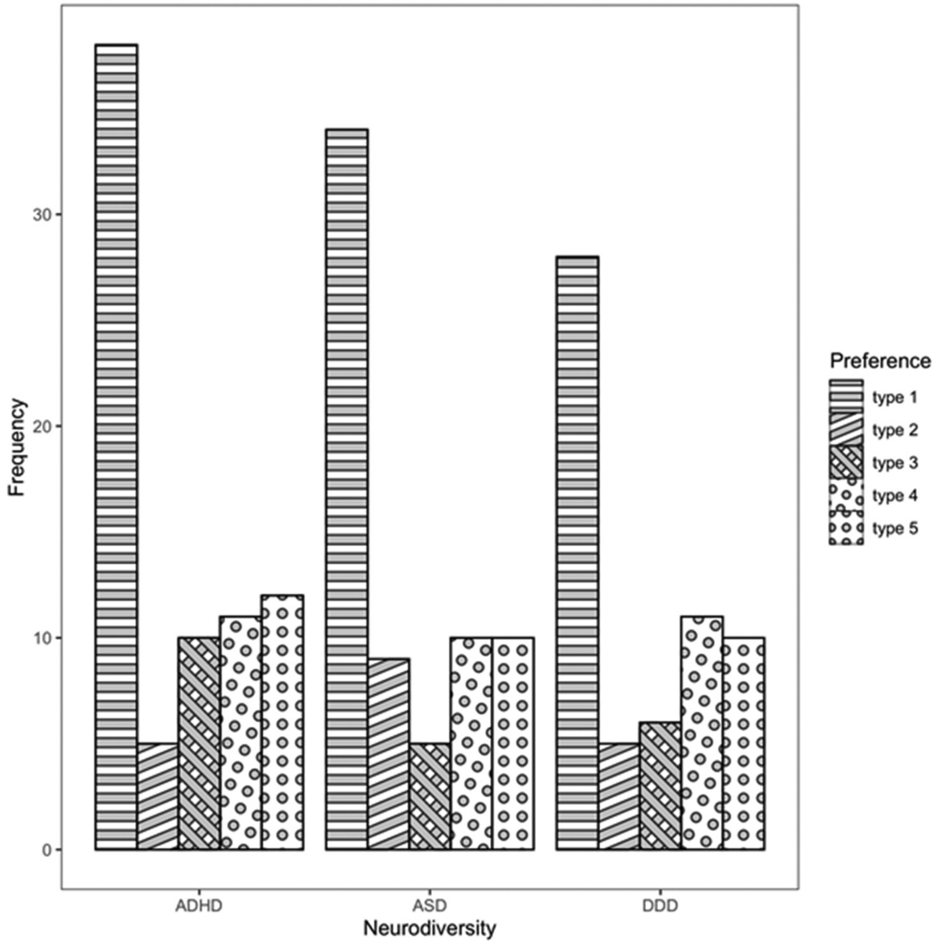

Figure 6. Pearson's chi-square test for rewards.

comprehension rather than increasing the legibility of text. Yaneva (2016) calls for an exploration of the factors related to legibility of texts such as font size, font types, line spacing, and background colours, as well as the extra-textual factors such as the presentation of text in bullet-point form and the emphasis of key words, to support their reading comprehension, some of the factors this research addressed.

The results indicate that people with ASD show clear preferences for factors such as font size, font style, character-spacing, line-spacing, style of instruction, and the style of the title to increase the readability of digital texts. Texts presented in a large (16 pt), sans-serif font style (Arial), with single character and line-spacing, in simple, bulleted sentences written in bold were found to be the most easily accessible. All of these findings fall within the guidelines set out by popular initiatives such as the Plain English Campaign and the Easy To Read Campaign that encourage accessible writing for people with NDDs (Tronbacke, 1997, as cited in Yaneva, 2016).

The data varied considerably for background colours and text emphases. Although all the participants, regardless of their NDD diagnosis, agreed that

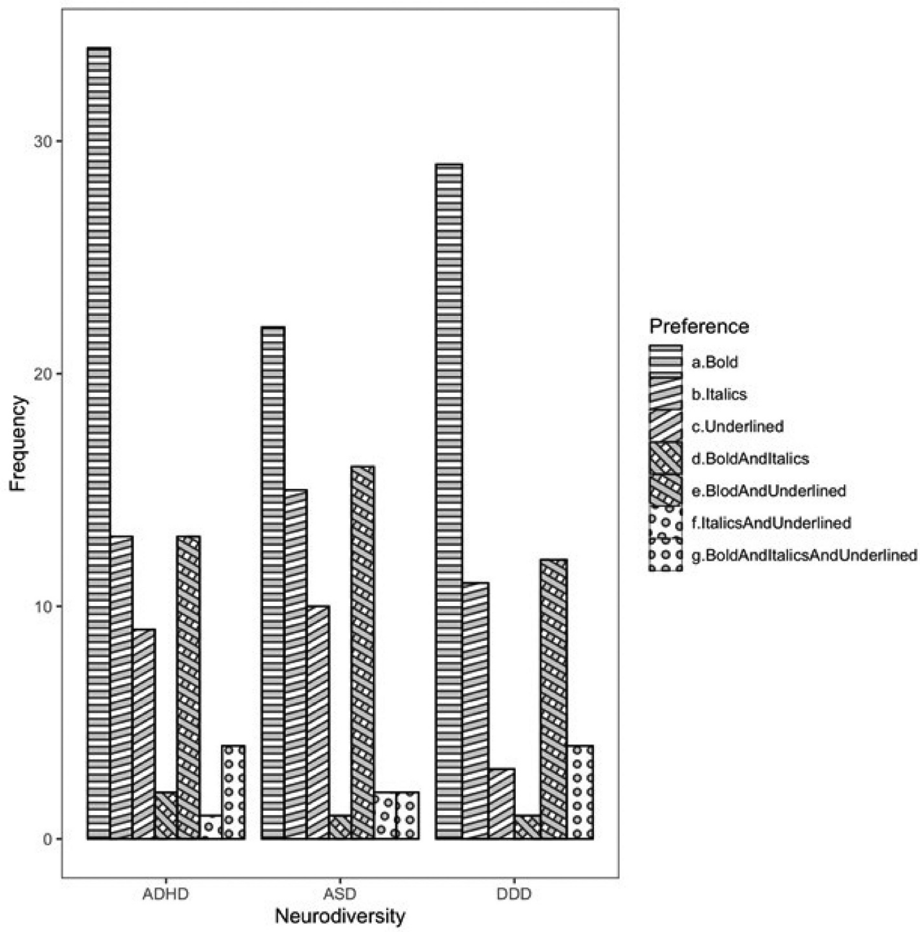

Figure 7. Pearson's chi-square test for title format.

a blue background colour was the easiest to read, the white background was ranked to be the favourite (38.2%) amongst participants with ASD. However, blue was a close second (35.2%), and yellow also received a significant proportion of the votes (22.1%). This finding is in line with other studies showing a wide variation in choice of colour for people with ASD (Ludlow et al., 2006). Interestingly, although the underlined title style was voted to be the easiest to read (ASD −50%; ADHD – 58%), the bold option was ranked to be the favourite, regardless of the NDD. The variance of these findings contributes to the breadth of research that recognises the importance of personalisation of the user interface to cater to the array of needs and preferences for people with ASD (Pavlov, 2014; Stern & Shalev, 2013; Yaneva, 2016). The findings of this study support the call to provide personalisation options for each user on digital platforms. This would not only allow greater accessibility across several NDDs, for other disabilities not discussed here, and wider user audiences (TEDx Talks, 2020).

Dyslexia, dyscalculia & dyspraxia

Similar to the ASD group, individuals in the DDD family had clear preferences for factors such as font size, font style, character-spacing, line-spacing, style of instruction, and the style of the title. Texts presented in a large (16 pt), sans-serif font style (Arial), with single character and line-spacing, in simple, bulleted sentences written in bold were found to be the most easily accessible. However, the DDD group is the only group that showed a consistent preference for bold text in both the Likert-scale and the rankings, whereas the ADHD and ASD groups agreed that the underlined emphasis was the easiest to read, although they ranked bold to be the easiest to read.

Although individuals in the DDD group also agreed that a blue background was easy to read, a yellow background was shown to be the preferred choice through the Likert-scale. This supports the findings of Rello and Bigham (2017), who suggested the use of warm background colours such as peach, cream, and orange (our yellow background was a warm, pastel yellow). Interestingly, although cool background colours such as blue and grey were advised against, our results show that although grey was the least favourite, contrary to the advice blue was the second favourite. A possible explanation for this is the lack of another warm colour presented to the participants. Interestingly, the preference of a white background to a grey one supports the findings in the comparative study done by Yoliando (2020), but is at odds with the guidelines published by the British Dyslexia Association (2020) which suggests the avoidance of a white background. The British Dyslexia Association suggests using a single colour background and not a white background. The complexity in the colour preferences of people with dyslexia further calls for a customisable interface, in which users can decide their own background colour. There is still a lack of understanding in how individuals with dyscalculia, dyspraxia, or a combination of these three disorders could be supported to improve the readability of texts especially with relation to colours. The high occurrence of comorbidity may have prevented this work from being undertaken, as it is difficult to get a large enough sample size, but it could still be worthwhile to delve deeper into improving text readability for people with any combination of DDD.

An interesting result to highlight is the clear preference for a sans-serif font style (Arial) for individuals in the DDD group. Although one of the font styles presented was a dyslexia-friendly typeface called OpenDyslexia, which was originally created to help the recognition of letters and reduce crowding effects (Galliussi et al., 2020), this style of font was removed from our results due to low statistical power. This supports the findings in Galliussi et al. (2020), in which no significant differences were found in reading speed and accuracy of people with dyslexia when reading texts written in dyslexia-friendly forms or with the standard letterforms (see also Kuster et al., 2018; Rello & Baeza-Yates, 2017; Wery & Diliberto, 2017).

Although 1.0 line-spacing was significantly preferred over 1.5x and 2x for all participants regardless of NDD, it was the 1.5x line-spacing that received the highest number of votes from the DDD group, with 81.6% agreeing that it was easy to read. On the contrary, when presented with all three line-spacing options, 1.0 line-spacing was ranked to be the easiest to read. It is worth noting that this group showed the greatest variance in this category, with 1.0 line-spacing receiving 45% of the votes, compared to 1.5x and 2.0x spacing that also received a significant number of votes – 28.3% and 26.7%, respectively.

This is in-line with Rello and Baeza-Yates (2017), where the differences in line spacing did not produce significant effects on text readability. These mixed results also partly support Yoliando (2020), which found that the effects of line spacing are less pronounced than factors such as font size and style.

This research was conducted with adults with neurodevelopment disorders and the findings provide insights into how the way materials are presented can be used by others to improve accessibility. If we extend this to educational settings, one needs to keep in mind that the state of development of younger people may be different from adults. For example, adults may have more established compensatory mechanisms and copy strategies that they have developed over time to manage their challenges (Livingston et al., 2020). Younger students may still be in the process of cognitive, emotional and social development making them more receptive to intervention although there might be more variability in their responses (Diamond & Lee, 2011). Therefore, for younger students, it is important to incorporate structured learning environments and developmental scaffolding, and to take into account each individual learner's needs when developing materials most suited to them.

Practical implications

The findings of this research lead to a few practical implications that educators can use focusing around three key points. First, standardise text design across educational materials. Using Arial font size 16 for all classroom materials, worksheets and presentations are advised based on our results. Arial is simple, clean, and highly readable for children, making it easier for them to process text quickly. While Open Dyslexia was designed for students with dyslexia, this study highlights the importance of testing assumptions about specialised fonts, as simpler styles like Arial may work better for broader populations. Readability research also suggest sans-serif fonts (like Arial) are easier for children to decode due to their clear letter shapes and spacing (Rello & Baeza-Yates, 2013). Second, adopt 1.5 line spacing as a default. Ensure that all printed and digital materials use x1.5 line spacing. Wider spacing reduces visual crowding, making it easier for young children to follow along with text, especially during early literacy development. Research on spacing indicates that increasing line spacing improves reading speed and comprehension, especially for early readers and students with dyslexia (Zorzi et al., 2012). Third, present instructions in a bullet-point format rather than lengthy paragraphs. This structure helps children break down tasks into manageable steps, reducing cognitive load and improving focus. Each bullet point should be concise and formatted using Arial font size 16 with x1.5 line spacing to enhance clarity. If possible, background colour should be formatted in accordance with the specific neurodiversity of the child – blue for those with ADHD, white for those with ASD and yellow for those with DDD. However, if producing materials for a diverse group or for the most generalisable accessibility, blue is the preferred colour to use. For reward symbols, a gold coin is the preferred option to use.

In the UK context, ASD is recognised under the Equality Act 2010, which mandates reasonable adjustments in educational settings to support individuals with ASD. This legislation ensures that schools provide tailored learning environments that accommodate the sensory and cognitive needs of autistic students. Policies such as the Special Educational Needs and Disability Code of Practice further guide educators in implementing inclusive practices that promote accessibility and participation for children with ASD (Department for Education & Department of Health and Social Care, 2015). In contrast, the United States has the ADA, which includes specific requirements for text-based materials to ensure accessibility for individuals with disabilities. The ADA mandates that educational content be presented in ways that accommodate diverse needs, such as using clear fonts, appropriate spacing, and alternative formats, underscoring the importance of the design principles highlighted in this study. Together, these policies reinforce the need for evidence-based approaches to text design that support all learners, particularly those with neurodiverse conditions.

Future research

This study provided quantitative insights into the preferences of different types of formatting for adults with different types of learning difficulties. These can tell us a lot about the preferences but not the underlying reasons as to why these were preferred. Future qualitative research could delve deeper into this topic and address the "why". In addition, studies could be conducted with people from a variety of age groups as these learning difficulties can develop over time (Zwart et al., 2019).

This study has started to address the gap in the literature with regard to presentation preferences for those with different neurodiversities. It has done so by testing factors related to text legibility (i.e., font size, font style, line and character spacing), as well as the extra-textual factors supporting comprehension (i.e., text emphases, use of bullet-point formats). The comprehensive overview and the results of the current study could be useful for education providers, EdTech developers, and people who provide online resources in general to ensure the resources they provide are optimal for the target audience.

Conclusion

Though there were some discrepancies between Likert scale results and ratings in each group, for almost all variables there was a clear preference overall. The preferences for font size, font style, line spacing, instruction layout, reward type, and title format were the same across the neurodiversity groups. This implies that structurally, the layout of learning materials using these variables does not need to differ when being presented to those with ADHD, ADD, and DDD. Background colour preference did differ between neurodiversity types; therefore, it may be useful to change the background colour of the learning material for each group or use interfaces where the user can select their own background colour. However, the blue background was most or second favoured in all groups. Another option, therefore, would be to use a blue background as a generalised format. Finally, these results can provide useful insights for people working in the education sector in the way materials are presented.

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