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RESEARCH ARTICLE

The impact of developmental dyslexia on workplace cognition: evidence from a virtual reality environment

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ABSTRACT
The cognitive difficulties associated with dyslexia persist into adulthood but insights into their impact in employment settings are lacking. A virtual office environment was used to assess two areas of cognition frequently called upon in the workplace, executive function and prospective memory. Eight adults with dyslexia and 27 adults without dyslexia were tested on a virtual office task. They read a scenario describing their new role in an office and were given tasks to complete. The group with dyslexia performed worse overall. On the individual performance measures, the group with dyslexia scored lower on the selective-thinking and planning measures of executive function and also performed worse on two of the three prospective memory measures, namely event-based and time-based prospective memory. The findings indicate how dyslexia can affect workplace cognition, identifying areas in which support might be needed and highlighting areas of relative strength which might be harnessed.

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Developmental dyslexia; executive function; prospective memory; virtual reality; workplace cognition

1. Introduction

Neurodiversity refers to all specific learning difficulties, such as attention deficit hyperactivity disorder, autism, developmental coordination disorder, and developmental dyslexia, which often co-occur or whose symptoms overlap. The recognition of, and support for, neurodiversity in the workplace has been growing in importance in recent years (e.g. Doyle 2020; Krzeminska et al. 2019; Ortiz 2020). The focus of the current paper is on one such condition, developmental dyslexia (henceforth, dyslexia). Dyslexia is typically characterised as a specific impairment affecting phonological processing and the subsequent development of reading and spelling (see, for example, a review by Castles and Friedmann 2014). However, broader cognitive deficits have also been found and these persist into adulthood (e.g. Brosnan et al. 2002; Smith-Spark et al. 2016; Provazza et al. 2019; Smith-Spark and Fisk 2007). As a neurodevelopmental condition, the effects of dyslexia persist into adulthood but the demands placed on cognitive resources in adulthood are likely to be very different from those required in childhood (e.g. McLoughlin, Fitzgibbon, and Young 1994). One clear and obvious difference is in the need for cognition in employment settings. While there is some literature on the impact of dyslexia in the workplace (e.g. de Beer et al. 2014; Doyle and McDowall 2015; Doyle and McDowall 2019), there is considerably less research that takes a specifically cognitive perspective on its effects in employment settings. The research reported in the current paper focused on two broader and inter-related areas of complex cognition, executive function and prospective memory (PM), which dyslexia has been found to affect in adults (e.g. Brosnan et al. 2002; Smith-Spark et al. 2016; Smith-Spark 2018) and which are relevant to the workplace. To this end, a virtual office environment was used in the current study to investigate how workplace performance might be affected by dyslexia-related deficits in these two complex aspects of cognition.

1.1. Dyslexia in the workplace

There is a relatively small literature on the effects of dyslexia in the workplace. However, a range of hindering or facilitative factors relevant to the challenges adult with dyslexia face in the workplace have been identified (de Beer et al. 2014). These include feelings and emotions about their condition, activities involving reading and writing, becoming employed and maintaining employment, attitudes of fellow employees and managers

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towards dyslexia, the availability of assistive technology in the workplace and other dyslexia-related accommodations, and self-disclosure and coping strategies. The positive effects of coaching on both literacy skills and cognition in the workplace have also been reported (Doyle and McDowall 2015; Doyle and McDowall 2019), with it being found (Doyle and McDowall 2015) that coaching topics were much more likely to be centred around executive function (relating in particular to working memory, organisational skills, and time management) than literacy-related skills. Indeed, it has been argued that problems with executive function are a 'prominent feature' (p. 162) of dyslexia in occupational settings (Doyle and McDowall 2015). A positive relationship between both planning and metacognitive abilities and job satisfaction and self-efficacy has been highlighted (Leather et al. 2011), although these factors were not found to relate to salary level, promotion or academic qualifications. There is also a small literature indicating the impact of dyslexia in the nursing profession (Illingworth 2005; Morris and Turnbull 2007), particularly highlighting the need for support and acceptance from colleagues and managers regarding the condition. Further to this empirical work, there are also books which have considered dyslexia in the workplace (e.g. Bartlett, Moody, and Kindersley 2010; Goodwin and Thomson 2012; Malpas 2012), identifying further challenges and providing some approaches to alleviating them. However, the effects of dyslexia on office jobs, and in particular the cognition related to carrying out duties in this kind of employment, are underexplored.

1.2. Complex cognition in the workplace

The executive functions are a set of higher-order cognitive abilities that enable goal-oriented behaviours (Gilbert and Burgess 2008). The cognitive mechanisms involved in goal success are inhibiting inappropriate behaviours (inhibition), switching attentional focus based on internal or external demands (task-switching), and concurrently processing and remembering information to enable rule maintenance and task focus (working memory) (Miyake et al. 2000). There is some evidence for the impact of executive deficits in the workplace, indicating a need for frameworks and practices which assist those who struggle with executive deficits (Cramm et al. 2013).

The PM system is responsible for remembering delayed intentions (Winograd 1988). Three types of PM task cue have been identified in the literature (e.g. Brewer et al. 2011), namely event-based, time-based, and action-based (also referred to as activity-based). Of these, event-based and time-based PM are the two most studied. In event-based PM, objects in the individual's surrounding environment act as cues to support PM (e.g. seeing a postbox should remind the individual that there is a letter in his or her bag which needs to be posted). Time-based PM requires an intention to be acted upon at or by a particular timepoint in the future (e.g. paying a bill by the end of the following week). Prospective memory of this kind is self-initiated and relies on internally-generated cues to support remembering, drawing upon executive function (e.g. Martin, Kliegel, and McDaniel 2003; McDaniel and Einstein 2000). Like event-based PM, action-based PM intentions are environmentally cued and require an intention to be carried out after another task has been performed (e.g. Brewer et al. 2011; Kvavilashvili and Ellis 1996). Action-based PM is the least cognitively demanding as the external cues associated with it coincide with the completion of the ongoing activity itself (Shum et al. 2004). Of the three cue types, time-based PM is the most cognitively complex and to draw on executive function to a greater extent than either event- or action-based PM (e.g. Einstein et al. 1995). The uses of PM in the workplace are manifold; for example, in remembering to carry out tasks, attach documents to emails, attend meetings, and pass on messages to colleagues. The real-world challenges of carrying out PM tasks are, for instance, in coping with interruptions, in dealing with busy and demanding situations, and monitoring for rarely occurring events over extended time periods (McDaniel and Einstein 2007). Its importance in safety-critical work settings has been highlighted (e.g. Loft, Dismukes, and Grundgeiger 2021), while PM has also been studied in a work environment through the use of active badges logging participants movements and actions during their work day (Sellen et al. 1997). The role of PM in recovering from interruption of work tasks has also been studied (e.g. Dismukes 2012). In the context of ergonomics, the role of PM has been investigated, for example, in air-traffic control (e.g. Loft 2014), driving behaviour (Sharma, Khan, and Kushvah 2020), intensive care units (Grundgeiger et al. 2013), and, more generally in complex sociotechnical systems (Grundgeiger, Sanderson, and Dismukes 2014). This literature indicates the involvement in, and importance of, PM across a range of employment settings and work tasks.

1.3. Study rationale and hypotheses

Executive function problems are well documented in dyslexia (see Smith-Spark and Gordon 2022 for a theoretical review of the links between dyslexia, executive function, and reading). Dyslexia-related problems with executive function have been found to persist into adulthood and have been documented under both laboratory conditions and in everyday life (e.g. Brosnan et al. 2002; Smith-Spark et al. 2016). In dyslexia, prospective memory difficulties have been found in adults on laboratory tasks (Smith-Spark, Zięcik, and Sterling 2016) and a clinical test (Smith-Spark, Zięcik, and Sterling 2017), under more naturalistic task demands (Smith-Spark, Zięcik, and Sterling 2016; Smith-Spark, Zięcik, and Sterling 2017; Smith-Spark, Zięcik, and Sterling 2017), and on self-report measures (Smith-Spark, Zięcik, and Sterling 2017; Smith-Spark, Zięcik, and Sterling 2016). Dyslexia appears to have its greatest impact on PM when cues to remembering are time-based rather than event-based, when the delay between forming an intention and being able to act upon it is prolonged, and when PM is required for one-off events (Smith-Spark 2018). There is, therefore, evidence of the continued impact of dyslexia on cognition in adulthood, some of which has highlighted its effects on everyday performance. However, a specific understanding of its effects in employment settings is lacking. The aim of the current study was, thus, to obtain a more direct assessment of the impact of dyslexia on workplace-related executive function and PM.

To this end, the Jansari assessment of Executive Function (JEF©) (Jansari et al. 2014) was used to provide a novel and ecologically valid assessment of executive function in adults. The JEF© uses a computer-based, non-immersive virtual reality environment to assess cognitive abilities across eight constructs. Resembling a computer game, the participants roleplay working in an office on their first day in a new job. The experimenter reads out loud a list of instructions to the participant from a prepared script, making them aware of the rules and procedures required of them. Participants navigate around the VR environment using a standard laptop keypad. They are required to interact with objects by clicking them with the computer mouse. The participant is scored on their performance for each task undertaken. Specifically, executive function is assessed by performance on tasks designed to measure planning, prioritisation, selection, adaptive-thinking, creative-thinking and multi-tasking. Planning requires the ordering of events or objects according to logic rather than their importance. Prioritisation reflects the ordering of events according to their perceived importance. Selective-thinking requires the individual to choose between alternatives by drawing on their existing knowledge. Creative-thinking measures how well individuals search for solutions using methods that are non-obvious or unspecified. Adaptive-thinking is related to the re-achievement of goals when conditions change. Multi-tasking reflects how well the individual is able to maintain progress on different tasks simultaneously. Prospective memory is assessed using tasks design to measure action-based PM (i.e. triggered by an action undertaken by the participant, such as a chair breaking when it is being moved), event-based PM (i.e. triggered by an event external to the participant, such as someone delivering a message to be noted) and time-based PM (i.e. a task to be performed at a specific time point). Tasks were chosen that might be considered typical in an office environment and were designed to appear to have more than one possible solution, but only one optimal solution.

Based on the literature reviewed in this section, it was hypothesised that the performance of the group with dyslexia would be lower overall on the JEF© (Jansari et al. 2014) than that of the group without dyslexia. On the individual JEF© measures, some predictions were also made based on the previous literature. Similarly, it was predicted that the dyslexia group would score lower on measures of planning as dyslexia-related planning deficits have been reported in adults in educational contexts (Galbraith et al. 2012; Mortimore and Crozier 2006; Gilroy and Miles 1996). However, despite strong implications for the role of executive functions in planning behaviours, this ability is under-explored in adults with dyslexia in the workplace. Due to the evidence for the role of executive functions in prioritisation and selective-thinking (e.g. Norman and Shallice 1986), it was predicted that the adults with dyslexia would perform worse on these tasks. Anecdotally, people with dyslexia have been argued to be high in creativity and this has been borne out in a recent meta-analysis (Majeed, Hartanto, and Tan 2021), at least in adults. It remained to be seen whether this would translate to better performance by the group with dyslexia on the creative-thinking measure of executive function. The Norman and Shallice Model of Control of Action (Norman and Shallice 1986) posits that the Supervisory Attentional System (SAS) interrupts automatic behaviours to adapt to environmental demands. Given the evidence for impairment in SAS-related abilities in dyslexia (Smith-Spark and Fisk 2007; Smith-Spark and Gordon 2022; Varvara et al. 2014), it was predicted that the group with dyslexia would score lower on the adaptive-thinking tasks. Dyslexia-related deficits were also expected to be found on the PM measures, with differences being more pronounced on the time-based PM measure (in line with Smith-Spark, Zięcik, and Sterling 2016; Smith-Spark, Zięcik, and Sterling 2017). Action-based PM has not previously been explored in dyslexia. However, since it is considered to be less cognitively taxing than event-based PM (Shum et al. 2004) and given the evidence indicating no event-based dyslexia-related PM deficits over shorter delay intervals (e.g. Smith-Spark, Zięcik, and Sterling 2017), it was expected that there would be a reduced impact of dyslexia on performance.

2. Method

2.1. Participants

A total of 35 university students (27 females, eight males, mean age = 24 years, *SD* = 5.63) with limited office-working experience took part. These participants were allocated to one of two groups based on their self-declared dyslexia status; those with dyslexia confirmed their diagnosis by showing the researcher a report written by an educational psychologist. The group with dyslexia consisted of eight participants (five females, three males, mean age = 25 years, *SD* = 5.84), while the group without dyslexia was made up of 27 participants (24 females, 3 males, mean age = 24 years, *SD* = 5.66). There was no statistically significant difference in age between the participant groups, $t(36) < 1$, $p = .670$. When asked by the experimenter, none of the participants without dyslexia identified any problems with reading or spelling.

As a further means of checking the allocation of the participants to the different groups, two additional tasks were administered to all the participants. These were the Nonsense Word Reading Passage (NWR) from the Dyslexia Adult Screening Test (DAST; Fawcett and Nicolson 1998) and the spelling component of the Wechsler Objective Reading Dimensions (WORD; Wechsler 1993).

The DAST NWR (Fawcett and Nicolson 1998) required the reading out loud of a short text containing both real words and orthographically legal nonsense words. The time taken to read the passage and the accuracy of reading performance were combined to provide a composite index of reading ability, following the method set out in the publication manual. On average, the group without dyslexia produced higher total scores on the DAST NWR (mean = 89.72, *SD* = 7.74) than the group with dyslexia (mean = 76.72 *SD* = 13.82). This group difference in reading ability was found to be statistically significant, $t(8.343) = 2.55$, $p = .033$, Cohen's $d = 1.22$. Levene's test for equality of variances was found to be significant, so a reduced number of degrees of freedom is reported.

The WORD spelling component (Wechsler 1993) required the spelling of individual words of increasing difficulty. Each word was read out loud by the experimenter, then read in the context of a sentence, then the individual word was repeated. Testing was terminated after six successive incorrect responses, in line with the guidance set out in the publication manual. Performance on the test yielded two measures of reading ability, the overall number of words spelled correctly and the spelling age of the participant (with a ceiling of < 17 years, indicating a spelling age in the typical adult range). The mean score of the group without dyslexia was 46.63 (*SD* = 2.02), while that of the group with dyslexia was 41.13 (*SD* = 4.42). The group difference in spelling scores was found to be highly significant, $t(33) = 5.04$, $p < .001$, Cohen's $d = 1.54$. Five of the eight participants with dyslexia had a spelling age of less than 17 years, while all the participants without dyslexia had spelling ages that fell in the typical adult range.

2.2. Materials

The JEF© (Jansari et al. 2014) is a virtual reality assessment wherein the participant assumes the role of an office assistant on their first day in a new job. Executive function was assessed by measures of planning, prioritisation, selection, creative thinking, and adaptive thinking. Prospective memory was assessed using three tasks related to action-based, event-based, and time-based PM. In total, there were 22 tasks (two for each construct); an example task for each construct follows, beginning with the executive function tasks and then moving on to the prospective memory tasks. One planning task involved rearranging the manager's tasks-for-completion into a logical order. A prioritisation task involved arranging five agenda topics to be discussed at the meeting in their order of importance. A task assessing selective-thinking required the participant to choose which mail company should be used to send each item of post, based on their speciality. One creative-thinking task was to find a way to cover graffiti written in indelible ink on a whiteboard in the meeting room. One task used to measure adaptive-thinking was to replace a broken overhead projector needed for use in the meeting. A multi-tasking task was to respond to an urgent memo while engaged in another task, with the participant being required to find a way of completing both tasks successfully. An example of an event-based prospective task was to make a note of the times of the fire alarms being tested prior to the start of the meeting. One time-based prospective memory task was to switch on the overhead projector 10 min before the scheduled starting time of the meeting. One JEF action-based prospective memory task was to note down any equipment that broke down or malfunctioned in the course of the day. Performance on each task was assessed using a three-level scoring system (0 = task not completed; 1 = partially completed; 2 = task completed) based on predetermined criteria. The scoring protocol has been validated using inter-rater reliability in previous studies (Jansari et al. 2004).

2.3. Design

A between-subjects design was employed. A multivariate analysis of variance (MANOVA) tested for group differences in performance on the JEF© (Jansari et al. 2014). The between-subjects factor was participant group (levels: group with dyslexia, group without dyslexia). The dependent variables were the eight JEF© measures (planning, prioritisation, selection, creative-thinking, adaptive-thinking, action-based PM, event-based PM, and time-based PM). To explore the relationship between dyslexia symptomatology and JEF© performance, Pearson's correlations were performed on the reading and spelling scores of all the participants and scores on the JEF©.

2.4. Procedure

Full ethical approval was granted by the School of Applied Sciences' Ethics Research Panel at London South Bank University (application number: SAS 1828). Testing was divided between two sessions, which occurred on different days. In the first, the reading and spelling measures were administered. In the second, the participants were presented with the virtual office task. They were asked to read a scenario describing their new role in an office and were then shown how to navigate around the office virtual environment. Once they had been given time to practice using the programme, they were given a list of tasks to complete. They were also told that their manager was not in the office that day. The participants were provided with a number of 'To Do' items throughout the assessment which created additional tasks or events, similar to those that would usually occur in an office environment. The participants were debriefed after the second testing session.

Table 1. Descriptive statistics for each of the individual JEF© measures.

Measure name	Mean (*SD*) of the group with dyslexia	Mean (*SD*) of the group without dyslexia
Planning	39.58 (8.63)	77.15 (18.57)
Prioritisation	81.25 (17.68)	86.11 (16.01)
Selective-thinking	81.25 (22.16)	96.30 (9.05)
Creative-thinking	43.75 (39.53)	33.33 (36.69)
Adaptive-thinking	81.25 (17.68)	83.33 (21.93)
Action-based PM	68.75 (29.12)	77.78 (25.32)
Event-based PM	68.75 (29.12)	91.67 (15.50)
Time-based PM	71.88 (20.86)	90.74 (12.30)

3. Results

The descriptive statistics for each of the individual JEF© measures are shown in Table 1. Inspection of the means indicates that the participants with dyslexia scored lower on all measures except creative-thinking, where they scored higher.

There was a highly significant multivariate effect of participant group on JEF© performance, Wilks' $\Lambda = .379$, $F(8, 26) = 5.34$, $p = .001$, $\eta_p^2 = .621$. The univariate F-test results are shown in Table 2. They indicated that the group with dyslexia performed significantly worse than the group without dyslexia on two of the five executive function measures (planning and selective-thinking) and two of the PM measures (event-based PM and time-based PM). The group differences on the remaining JEF© measures were not found to be statistically significant.

The Pearson's correlation matrix is shown in Table 3. Spelling ability, as measured by the WORD spelling component, was significantly correlated with scores on the JEF© planning, event-based PM, and time-based PM measures. Reading ability, assessed by the DAST NWR, was found to have significant associations with scores on the JEF© prioritisation, event-based PM, and time-based PM measures.

4. Discussion

In this study, the workplace cognition of adults with dyslexia was compared with that of adults without dyslexia using the virtual reality JEF© (Jansari et al. 2014). Overall, the participants with dyslexia performed at a lower level than the participants without dyslexia, indicating deficits in the application of executive function and PM to work-related tasks. Group differences were found on two of the executive function measures,

Table 2. Univariate F-test results for the individual JEF© measures.

Measure name	$F(1, 33)$	p	η_p^2
Planning	30.28	< .001	.479
Prioritisation	< 1	.466	.016
Selective-thinking	8.28	.007	.201
Creative-thinking	< 1	.493	.014
Adaptive-thinking	< 1	.808	.002
Action-based PM	< 1	.398	.022
Event-based PM	8.78	.006	.210
Time-based PM	10.38	.003	.239

Table 3. Correlations between the reading and spelling measures and the JEF© measures.

Measure	WORD	NWR	Planning	Prioritisation	Selection	Creativity	Adaptiveness	ABPM	EBPM	TBPM
WORD spelling	–									
DAST NWR	.811***	–								
Planning	.533**	.403	–							
Prioritisation	.163	.516*	.013	–						
Selection	.285	-.205	.227	.158	-					
Creativity	.623	.049	-.253	.214	.079	-				
Adaptiveness	.428	.289	-.058	.358*	.256	.031	-			
Action-based PM	.037	.310	.221	.156	-.134	-.256	.193	-		
Event-based PM	.593***	.528*	.302	.138	.457**	-.160	.331	.183	-	
Time-based PM	.504**	.517*	.263	.454**	.592***	.125	.482**	.023	.561***	-

Key: ABPM = action-based PM; EBPM = event-based PM; TBPM = time-based PM; * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

namely planning and selective-thinking, with the group with dyslexia performing worse than the group without dyslexia on both the measures. As noted previously, the planning measure assesses the ability of the participant to order events or objects on the basis of logic (and not relative importance). The group difference on this measure is in line with the literature related to dyslexia-related planning difficulties in adulthood (Galbraith et al. 2012; Mortimore and Crozier 2006; Gilroy and Miles 1996). Selective-thinking refers to the ability to draw on acquired knowledge to choose between two or more alternatives. Controlled access to information from long-term memory has been shown to be impaired in people with dyslexia. For example, adults with dyslexia have been found (e.g. Smith-Spark et al. 2017) to perform worse on verbal fluency tasks in which participants have to generate as many items beginning with a certain letter as they can in one minute according to certain rules. Given that selective thinking requires rapid access to existing information stored in memory, it could be argued that this finding adds to the small amount of extant research in this area and shows a way in which such difficulties might affect everyday cognition. Employees with dyslexia need to be aware of potential difficulties with planning and selective thinking and discuss with employers alternative strategies or software applications that might support them.

The group with dyslexia also performed worse on two of the three PM measures compared with the non-dyslexic group, with deficits being shown on both the event-based and time-based PM measures. In line with previous findings (Smith-Spark, Zięcik, and Sterling 2017), the effect size was larger (albeit slightly) for time-based PM than for event-based PM. As argued previously, time-based PM is considered to be more executive-loaded (e.g. Martin, Kliegel, and McDaniel 2003; McDaniel and Einstein 2000) and, given the executive function problems in dyslexia, likely to be more prone to the effects of the condition (see Smith-Spark 2018). No group difference was found on the action-based PM measure. As stated in the Introduction, this form of PM is considered to be both the least complex (Shum et al. 2004) and the most environmentally-supported (Brewer et al. 2011; Kvavilashvili and Ellis 1996). These task qualities are likely to explain the absence of a group difference on this measure. Areas of relative strength in PM could be utilised to improve performance to a level at least equivalent of that of individuals without dyslexia (Smith-Spark 2018). From the current data, it would seem that workers with dyslexia should aim, wherever possible, to change the nature of the work-based PM tasks that they are assigned so that they can rely on action-based cues.

As further support for the relationship between dyslexia symptomatology and aspects of work-based cognition, significant positive correlations were found between scores on the reading and spelling measures and several JEF© measures. In the case of the executive function measures, planning was correlated with spelling ability and prioritisation with reading ability. A more consistent pattern was found with the PM measures, with both reading and spelling ability being associated with event-based and time-based tasks, but not action-based tasks. The results from the current study, therefore, add to the evidence that adults with dyslexia might struggle performing work-related planning tasks and that, more generally, their difficulties are not confined to literacy-related tasks. This finding, therefore, has important implications for applied settings and for dyslexia theory.

Support for executive function difficulties might be gained from executive function training, although the benefits of such training tend to be limited to the task on which the individual is trained and do not tend to transfer to other tasks (e.g. Diamond 2013). A review of prospective memory in dyslexia (Smith-Spark 2018) has identified several approaches to improving memory for delayed intentions, such as strengthening the association between prospective memory cues and actions and implementation intentions (e.g. Gollwitzer 1999), audio-recording instructions for later playback, and, as already mentioned, converting the nature of the prospective memory task cue so that it is less cognitively complex. In providing people with dyslexia with software applications to support their cognition, organisations and employees with dyslexia alike need to be aware that it is likely not to be sufficient simply to hand a piece of technology over to the individual and expect them to use it effectively. Instead, support will need to be provided in order to ensure that it is adopted and used to its full extent. The range of mobile technological support devices available to adults with dyslexia has been highlighted (Reid, Strnadová, and Cumming 2013). However, as considered by Smith-Spark, Zięcik, and Sterling (2017), adults with dyslexia still reported more frequent everyday problems with prospective memory even after controlling statistically for an increased use of tools and techniques to assist memory. While statistically non-significant, it is still worth noting that the group with dyslexia scored higher on the creative-thinking measure. A meta-analysis of 14 studies of creativity in children and adults with dyslexia (Majeed, Hartanto, and Tan 2021) indicated that, while there was no overall group difference, adults with dyslexia significantly outperformed adults without dyslexia on tests of creativity. The results of the current study bear this out to an extent (albeit non-significantly) and indicate a possible strength of employees with dyslexia and an area in which they might contribute very successfully.

There are several limitations to the current study that need to be acknowledged. Firstly, the participants were university students rather than office workers. Further work is thus needed to examine any mitigating role that office experience might play in the performance of workers with dyslexia and how their working environment might support their cognition (c.f., extended cognition; e.g. Zhang and Norman 1994). Secondly, the number of participants in the group with dyslexia was small but, where significant group differences were found, the effect sizes were relatively large and the general pattern of the findings is very similar to that found in laboratory-based studies with larger Ns (see reviews, Smith-Spark 2018; Smith-Spark and Gordon 2022). Thirdly, it should be noted that no measure of IQ was administered to indicate whether group differences existed in general cognitive ability level but the findings are consistent with previous work where measures of IQ were taken (Smith-Spark, Zięcik, and Sterling 2016; Smith-Spark, Zięcik, and Sterling 2017) and in which no group differences in IQ were found.

This virtual reality study has allowed the direct study of workplace cognition in adults with dyslexia, indicating areas of weakness and relative strength in executive function and PM abilities that are relevant to office settings. The knowledge gained from this study can help in providing targeted support for employees with dyslexia in areas of workplace cognition beyond those drawing on literacy-related skills. There is also a need for these areas of potential difficulty to be communicated effectively to the line managers and colleagues of employees with dyslexia so that they are aware of the cognitive challenges presented by dyslexia and can shape their demands and expectations appropriately. Moreover, it can be fed into careers advice to identify jobs with the best fit in terms of cognitive profile. Moreover, it could also be utilised in job crafting, with benefits for job satisfaction, work engagement, and work performance (e.g. Bakker, Tims, and Derks 2012). The findings of the current study also highlight the value of virtual reality methodologies in testing real-world cognition, both generally and in relation to particular groups of individuals. In the current study, it has allowed insights into the ways in which neurodiversity (in the form of dyslexia) can be expressed in the workplace and has emphasised the need for appropriate support to be in place to help all individuals achieve their full potential and to gain maximum satisfaction in their work.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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