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The event-based prospective memory of adults with developmental dyslexia under naturalistic conditions

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Abstract

Prospective memory (PM) is memory for delayed intentions. Broadly speaking, PM tasks require responses either to events in the environment (event-based PM; EBPM) or at a specific point in time (time-based PM; TBPM). Dyslexia-related deficits in TBPM have been reported under laboratory conditions but group differences in EBPM have yet to be found. However, self-reports suggest that people with dyslexia do experience day-to-day EBPM difficulties. To determine whether EBPM was affected by dyslexia when task demands were more closely related to the demands of everyday life, a task was presented to groups of adults with and without dyslexia, matched for age and short-form IQ. The participants were required to make a response outside the laboratory setting one week after the task had been set. The group with dyslexia were worse at remembering to perform the EBPM task one week later, despite reporting equivalent levels of motivation to perform it successfully. Fewer adults with dyslexia reported remembering the PM instruction at the time it was required. However, they did not differ from adults without dyslexia in the self-reported frequency with which they thought of the PM task over the intervening period. The results suggest that EBPM deficits can be found in dyslexia over longer delay intervals. Dyslexia-related problems with EBPM may relate to the reliable access to verbal information at the point at which it is required. These results are considered in the light of the current understanding of PM impairments in dyslexia.

Keywords: Developmental dyslexia; Adults; Prospective memory; Event-based prospective memory; Episodic retrieval

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Whilst research into dyslexia has been predominantly focused on understanding the phonological processing difficulties experienced by individuals with the condition (e.g., Castles & Friedmann, 2014; Vellutino, Fletcher, Snowling & Scanlon, 2004), dyslexia- related difficulties with various aspects of memory have also been identified (e.g., Jorm, 1983; McNamara & Wong, 2003; Menghini, Finzi, Carlesimo & Vicari, 2011; Smith-Spark & Fisk, 2007; Smith-Spark, Fisk, Fawcett & Nicolson, 2003). However, one particular type of memory, prospective memory (PM), has hardly been scrutinized. Prospective memory is memory for delayed intentions (Winograd, 1988) or remembering to remember (Mäntylä, 1994). The lack of empirical scrutiny is a potentially serious oversight given the likely impact of PM failures on day-to-day life across employment, social, and personal settings (e.g., McDaniel & Einstein, 2007). Dyslexia is a lifelong condition and individuals continue to experience its effects when they reach adulthood (e.g., Fawcett, 2014; McLoughlin, Fitzgibbon & Young, 1994). Indeed, in the case of PM, the impact of deficits will be much greater in adulthood when an individual is responsible for ensuring that a variety of tasks are completed successfully at the point in the future at which they need to be. This responsibility stands in contrast to childhood where parents, carers, and teachers undertake many of the behaviours relating to PM on behalf of the child, acting as a kind of external memory (c.f., Clark & Chalmers, 1998). There is an especial need for more research on PM in everyday situations since such research can provide an evidence base upon which to draw when supporting adults with dyslexia in educational or workplace settings. The research reported in the current paper sought to address explore PM outside the laboratory setting, employing a task which needed to be performed one week after being set, when the participants were out of the laboratory and in "the wild".

There are two components of performance which are common to all PM tasks (e.g., Einstein & McDaniel, 1996). Firstly, there is a prospective or planning component. This acts to ensure that the intention is brought to mind at the appropriate point in the future (e.g., remembering in the evening to carry out a task identified at breakfast that day). Secondly, there is a retrospective component. This allows the actual contents of the intention itself to be recalled (e.g., buying a litre of milk in the evening to replace the bottle finished at breakfast).

In addition to these two PM components, there are two broad types of PM. These are known respectively as event-based (EBPM) and time-based (TBPM) PM. When a PM task is event-based, objects in the surrounding environment act as cues to prompt the enactment of the intention (e.g., seeing a friend prompts a person to remember the intention to pass on a message to him or her). Time-based PM tasks require an individual to remember to carry out an intention at a certain time in the future (e.g., remembering to Skype a colleague at 12:30pm or return a telephone call to a friend in 30 minutes' time). Because an individual cannot rely

on external prompts to remember a TBPM task, internally-generated strategies are required instead to ensure that it is performed successfully. Such internally-generated strategies would include, for example, remembering to check a clock regularly to update and/or calibrate one's representation of the current time (and the time still remaining until the TBPM response is needed) or reminding oneself of the intention from time to time over the intervening period between forming the intention and remembering to perform it. Time-based PM is, thus, more self-initiated than EBPM, with the individual having to engage in more strategic, self-generated processes to guide performance (e.g., Einstein, McDaniel, Richardson, Guynn & Cunfer, 1995).

Finally, PM tasks can also be either episodic (being one-offs or infrequently occurring; such as remembering to post a birthday card to a friend who has moved away) or habitual (being those performed on a regular basis, such as remembering to take prescribed medication at the correct times of day).

As already stated, there is presently only a small corpus of research on PM in dyslexia. Moreover, studies exploring PM in its own right have only emerged very recently. There are, however, some earlier papers in the literature reporting difficulties that could be construed as drawing upon processes which share commonalities with those involved in PM. Problems with organization (Torgeson, 1977) and planning (Levin, 1990) have been found in children with dyslexia under laboratory-based conditions. Further to this, Augur (1985) presented anecdotal reports of increased forgetfulness in dyslexia. Self-report evidence (Leather, Hogh, Seiss & Everatt, 2011; Smith-Spark, Fawcett, Nicolson & Fisk, 2004) has also suggested difficulties with PM based on responses to individual items of a well- established questionnaire designed to measure everyday problems with cognition (the Cognitive Failures Questionnaire; Broadbent, Cooper, FitzGerald & Parkes, 1982).

A diary study by Smith-Spark (2000) indicated a greater susceptibility to forgetfulness in adults with dyslexia than an age- and IQ-matched control group. He asked participants to keep a diary of any errors that they made in their day-to-day lives over a two- week period, noting down the nature of the slip. One category of error reported by the participants was termed "forgetfulness" by Smith-Spark. The acts of forgetfulness reported by both participant groups were often retrospective or episodic in nature (e.g., forgetting where possessions had been left or failing to remember previous actions), but many of the errors were, instead, prospective in nature (e.g., forgetting to pay bills on time or failing to return library books as intended). In identifying the latter source of errors, Smith-Spark first raised the question explicitly as to whether PM was impaired in dyslexia. However, this issue was tangential to the focus of his research and was, thus, not fully explored at that time.

Khan (2014) was the first author to provide self-report evidence of PM impairments in dyslexia. He administered

the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie & Maylor, 2000) to a large sample of schoolchildren of varying ages. Khan found that the children with dyslexia reported more frequent memory problems and that these difficulties affected both PM and retrospective memory. These self-report findings from children thus show a similar pattern to those obtained in Smith-Spark's (2000) diary study with adults, highlighting dyslexia-related difficulties in both prospective and retrospective domains of memory.

Smith-Spark, Zięcik, and Sterling (2016a) also used the PRMQ (Smith et al., 2000) to explore PM in dyslexia but tested adults, rather than children. The adults with dyslexia self-reported a greater incidence of PM failures across both short and long intervals between forming an intention and the opportunity to act upon it. This higher frequency of problems was reported across both environmentally-cued and self-initiated types of PM. More frequent retrospective memory difficulties were also self-reported by the group with dyslexia. Further to giving participants the PRMQ to complete, Smith-Spark et al., also administered the proxy- rating PRMQ (Crawford, Henry, Ward & Blake, 2006) to family and close friends of the PRMQ respondents. This required the close associates to rate the memory of the PRMQ respondents using the same set of 16 questions. More frequent PM failures were again identified as being experienced by the adults with dyslexia than those without the condition. The proxy-ratings thus corroborated the reports of the PRMQ respondents.

Prospective memory difficulties have, thus, been identified by people with dyslexia as more frequently occurring in everyday life (e.g., Khan, 2014; Smith-Spark, 2000; Smith- Spark et al., 2016a). In addition to this self-report evidence, there is also a very small literature investigating PM performance in adults with dyslexia under laboratory conditions.

Smith-Spark et al., (2016b) found that adults with dyslexia produced lower levels of accuracy on a computerized TBPM task compared with a group of adults without dyslexia who were matched for short-form IQ. The participants were asked to perform an ongoing task in which they made judgements as to whether arrays of famous faces contained more photographs of living or dead celebrities. Involvement in an ongoing task from which it is necessary to break out to perform a PM task is a typical paradigm in PM research (e.g., McDaniel & Einstein, 2007) and is argued to simulate the conditions under which PM is called upon in day-to-day life; it is seldom the case that people are in a position to remain focused solely on the PM task over the delay between forming an intention and being able to act upon it. Instead, life with its attendant activities tends to intercede. Thus, in Smith-Spark et al.'s study, the participants were instructed to break out from the ongoing task to make a PM response every three minutes. This PM response involved pressing a key on a computer keyboard connected to a computer which was placed out of direct view of the participant (so that no event-based cues were available to prompt PM responses). The same computer was also

programmed to display a clock showing how much time had elapsed since the start of the experiment. This clock was shown whenever a particular key was pressed on the keyboard behind the participant. The participants were allowed to make as many clock checks as they liked over the course of a 16-minute TBPM trial. The adults with dyslexia made significantly fewer correct PM responses than the adults without dyslexia. They also made significantly fewer clock checks to facilitate their PM performance. However, there was no difference in their accuracy levels between the two participant groups in response to the ongoing task. The results are, therefore, suggestive of a problem with breaking out from ongoing behaviour to respond to the PM task at the appropriate time.

In the same paper, Smith-Spark et al., (2016b) also investigated performance on a semi-naturalistic TBPM task. This required the participants to remind the experimenter to save a data file 40 minutes after having been given the instruction. The adults with dyslexia were found to be more likely to fail to remind the experimenter than the adults without dyslexia. Thus, TBPM problems were found by Smith-Spark et al., in the same sample of adults with dyslexia under both laboratory and semi-naturalistic conditions.

A further study by Smith-Spark, Zięcik & Sterling (in press) explored PM performance across both controlled laboratory and everyday conditions. They administered a clinical test of PM, the Memory for Intentions Test (MIST; Raskin, Buckheit & Sherrod, 2010), to adults with and without dyslexia, matched for short-form IQ. The adults with dyslexia showed reduced levels of PM accuracy overall. More particularly, they performed more poorly than adults without dyslexia when time cues were used (e.g., "In 15 minutes, tell me to check my mail."). This decrement in TBPM was in contrast to their performance when event-based cues were available to prompt remembering (e.g., "When I hand you a red pen, sign your name on your paper."). In this case, the two participant groups performed at equivalent levels, suggesting no dyslexia-related difficulties with EBPM. Group differences were also found in the same participants on a more naturalistic TBPM measure, with the adults being less likely to remember to leave a voicemail message, as instructed, for the experimenter 24 hours after completing the MIST testing session. In addition to these objective measures of PM performance, the Prospective Memory Questionnaire (PMQ; Hannon, Adams, Harrington, Fries-Dias & Gibson, 1995) was administered to the same participants to assess the frequency of PM failures in day-to-day life over a range of different time periods. The adults with dyslexia reported more frequent problems with PM overall.

Differences were found on two of the three PM subscales. The group with dyslexia identified one-off PM tasks over longer time intervals and PM tasks requiring internally generated reminders as leading to more frequent errors. The two groups did not differ in their self-reported frequency of errors in habitual PM over the short-term. Finally, the adults with dyslexia reported using tools and

strategies to facilitate their PM more frequently than the adults without dyslexia. Despite this increased reliance on memory aids, they still felt that their PM performance was more error-prone than the adults without dyslexia over the same period. Smith-Spark et al., thus found PM deficits in the same group of adults with dyslexia under both laboratory and everyday settings.

There is, then, a small body of evidence to indicate PM deficits in dyslexia. Emerging from these studies are the ideas that TBPM is more affected by dyslexia than EBPM and that difficulties can be found under both laboratory-based and everyday conditions. However, the impact of PM deficits on everyday situations is generally limited to self-reports of dyslexia- related deficits from children (Khan, 2014) and adults (Smith-Spark et al., 2016a; Smith- Spark et al., in press), supplemented by findings from two naturalistic TBPM tasks with different delay intervals between intention formation and the opportunity to act upon the intention (40 minutes and 24-hours; Smith-Spark et al., 2016b, and Smith-Spark et al., in press, respectively). The study reported in the current paper was conducted in order to extend the literature on more naturalistic PM in dyslexia, employing more naturalistic task conditions over an extended time period and exploring EBPM, rather than TBPM.

As mentioned previously, Smith-Spark et al., (in press), found that adults with dyslexia reported themselves as experiencing more frequent PM problems on Hannon et al.'s (1995) Prospective Memory Questionnaire (PMQ). More particularly, the adults with dyslexia identified greater difficulties with Long-Term Episodic PM than the controls, whilst there was no group difference in Short-Term Habitual PM. These findings would, therefore, suggest that EBPM performance is more likely to be affected by dyslexia when task conditions are such that tasks are one-off in nature and require a response more distant in time from the point at which the intention was formed. To explore this hypothesis, the participants were asked to respond to a text message sent to their mobile 'phone one week after they had attended a laboratory-based testing session. The text message, thus, acted as an EBPM cue. The required response involved placing a missed telephone call to the experimenter. The task requirements were quite novel in that it is not often the case that an individual needs to remember to leave a missed call for someone. The task is, therefore, to be viewed as testing episodic, long-term EBPM.

In order to determine the extent to which problems with retrospective memory and the accessing of instructions relating to the PM task at the point at which they were required, the participants' retrospective memory for the PM task instructions was also tested. Dyslexia-related problems with episodic or retrospective memory have been found over the short-term (Menghini, Carlesimo, Marotta, Finzi & Vicari, 2010) and the long -term (McNamara & Wong, 2003). This experimental evidence identifying poorer autobiographical and/or semantic recall in dyslexia is complemented by self-reports of more frequent difficulties with retrospective memory in daily life from

both children (Khan, 2014) and adults with dyslexia (Smith-Spark, 2000; Smith-Spark et al., 2016a). As mentioned previously, all PM tasks contain a retrospective component as well as a prospective (or planning) component (Einstein & McDaniel, 1996). One possible explanation for reduced PM performance in dyslexia could, therefore, reside in a lowered ability to store, maintain, and access verbal material in long-term memory (Smith-Spark, 2017). Problems in this component of PM might play out in less ready access to details of the PM task intended to be carried out, resulting in a failure to remember what it was that needed to be done at the point at which it needed to be performed.

The participants were asked, therefore, to indicate whether they had remembered the instructions after the opportunity to complete the PM task had passed. Greater retrospective memory problems in the group with dyslexia (e.g., McNamara & Wong, 2003; Menghini et al., 2010; Smith-Spark, 2000; Smith-Spark et al., 2016a) were expected to play out in lowered reports of remembering the detail of the PM instructions given to them a week earlier. The participants were also asked to estimate how frequently they had thought about the PM task in the week's interval between being given the PM instruction and receiving the text message which required the PM response. This measure would provide some indication of the extent to which the prospective component of the task might be responsible for any EBPM performance decrement in the group with dyslexia, showing the extent to which internally-generated processes were employed by both groups to guide remembering over the time-course of the study.

Method

Participants

The participants were allocated to one of two groups based on their self-declared dyslexia status, resulting in a group of 26 adults with dyslexia (21 females, 5 males) and a group of 25 adults without dyslexia (19 females, 6 males). The two participant groups did not differ significantly in age, $t(48) < 1$, $p = .809$. The participants were given course credit or an honorarium for taking part.

The self-declarations of dyslexia status were checked by the experimenter prior to the commencement of testing. All of the participants with dyslexia showed the experimenter an educational psychologist's report which confirmed their diagnosis. The participants without dyslexia were asked to report whether they had any reading or writing difficulties. None of the participants in the control condition reported any such problems. Course credit or a small honorarium were given to participants in appreciation of their time. Table 1 shows the group descriptive statistics for all of the background characteristics reported in this subsection.

Whilst Nicolson and Fawcett (1997) have reported that individuals are highly accurate in reporting that they do not have dyslexia, measures were taken of the reading and writing abilities of all of

Table 1: Background characteristics of the participants. Standard deviations are shown in parentheses.

	Group with dyslexia (N = 26)	Group without dyslexia (N = 25)
Age (years)	23.69 (3.86)	23.40 (4.70)
WAIS-IV short-form IQ	107.23 (7.90)	107.18 (9.64)
DAST NWR test raw score	77.65 (11.75)	92.20 (3.23)
WORD spelling test raw score	40.38 (3.83)	44.88 (1.67)

the participants as a further means of ensuring the validity of the participant groupings.

The Nonsense Word Reading (NWR) subtest from the Dyslexia Adult Screening Test (DAST; Fawcett & Nicolson, 1998) was used to assess reading abilities. The participants were required to read a short passage containing a mixture of real words and orthographically legal nonsense words. Continuing problems with the decoding of nonsense words have been found in adults with dyslexia, even when their reading is otherwise compensated (Brachacki, Fawcett & Nicolson, 1994; Finucci, Guthrie, Childs, Abbey & Childs, 1976). This continued difficulty means that the NWR task is a very good indicator of the underlying impact of dyslexia on reading in adulthood. All of the participants without dyslexia scored at or above the age-related normative cut-off, scores below which identify an individual as being "at risk" of dyslexia. The DAST NWR raw scores, therefore, indicated that the reading performance of the adults without dyslexia was in the typical adult range. A total of 18 out of 26 individuals in the group with dyslexia had NWR scores falling in, at least, the "at risk of dyslexia" range. The group with dyslexia obtained a significantly lower mean raw score than the group without dyslexia, $t(28.894) = 6.08$, $p < .001$, $d = 1.29$.

To measure spelling ability, the spelling component of the Wechsler Objective Reading Dimensions (WORD; Wechsler, 1993) was administered to the participants in both groups. The participants were requested to spell words of increasing complexity. The experimenter read aloud the word to be spelled, then read out a contextualising sentence containing the word, and then repeated the word itself. The participant then wrote down their response. Testing was terminated by the experimenter after six successive incorrect spellings, consistent with the published

administration guidelines. The participants with dyslexia were found to have a lower mean WORD spelling raw score, $t(34.436) = 5.47$, $p < .001$, $d = 1.08$. A spelling age was then derived from the raw score, with a spelling age of greater than 17 years being the ceiling for the task. Raw scores of 42/50 or more on the test indicated spelling abilities in the adult range. Seventeen of the participants with dyslexia were found to have spelling ages of 17 years or less, whilst all of the participants in the group without dyslexia had spelling ages which were greater than 17 years.

The participant groups were also matched for short-form IQ. Four subscales (Verbal Scale: Comprehension and Vocabulary; Performance Scale: Block Design and Picture Completion) were administered from the Wechsler Adult Intelligence Scale- Fourth UK Edition (WAIS-IV; Wechsler, 2010). The four subscales were selected on the basis that they were not sensitive to the presence of dyslexia and, therefore, allowed a between-subjects comparison of IQ that was independent of the effects of dyslexia (Turner, 1997). Scaled scores from these subtests were then used to calculate a short-form IQ for each participant, employing the method set out by Turner. No significant difference in short-form IQ was found between the adults with and without dyslexia, $t(49) < 1$, $p = .985$.

Materials

A dedicated 'phone number and email address were set up to allow the experimenter to send and receive the messages which were required over the various stages of the study.

A short questionnaire on mobile 'phone usage was used to check that technical problems would not affect the ability of any of the participants to complete the study to the best of their ability. For each question presented, participants rated their competence on a 10- point scale, with 10 indicating the highest level of competence in the relevant aspect of mobile 'phone use.

Design

A 2 x 2 Chi-square design was employed. The predictor variable was the participant group (participants with dyslexia and participants without dyslexia) and the criterion variable was the response to the naturalistic PM task (whether the participant remembered to respond correctly by placing a missed call to the experimenter or not).

Procedure

Informed consent was acquired from all of the participants prior to testing. The participants were informed that they would receive a text message one week after they had attended the laboratory for a testing session. They were told that this text message would contain their initials and their participant number.

The PM task itself required the participants to leave a missed call for the experimenter back once this text message was received. The participants were asked to reply to this text message as soon as possible and, preferably,

within five minutes of receiving the text. They were requested to reply by using the same telephone number which received the incoming message. This was done to allow the experiment to log the 'phone number of the participant and then match it with the participant's identification number. In order to avoid the participants incurring any telephone charges relating to their participation in the study, the participants were instructed to wait for the 'phone to ring once and then to hang up to end the call before it was answered. Consistent with previous research (e.g., Kvavilashvili & Fisher, 2007; Rendell & Craik, 2000), the participants were requested not to use any external reminders such as calendar entries or sticky notes to aid their performance. This instruction was given so that the participants would rely purely on PM to perform the task successfully rather than on external reminders.

After the PM instructions were presented, the participants' understanding of the PM task requirements was checked. All of the participants reported that they understood what was required of them and repeated the instructions back to the experimenter verbally.

In order to ensure that all of the participants would be able to respond to the PM- related text message when they received it, several questions relating to mobile 'phone usage were presented. Firstly, the participants were asked whether their 'phones were on a pay- monthly or pay-as-you-go tariff in order to rule out any participants who might not be able to respond to the text message because of insufficient funds. If a participant reported having a 'phone on a pay-as-you-go tariff, he or she was asked whether there were long periods of time when there were no funds on his or her account to make 'phone calls. Secondly, the participants' self-rated competency with using mobile 'phones for calls, text messages, and returning 'phone calls to senders of text messages was assessed. Thirdly, the participants were asked to estimate how many times they checked their mobile 'phone for messages each day.

One week after they had received the instructions relating to the PM, the participants were sent the text message to which they were required to respond.

A further week after sending the PM-related text message, the experimenter sent a follow-up email asking whether or not the participant had received the text message and, if so, whether he or she had successfully remembered the instructions relating to the task that he or she was meant to perform. In this email, the participants were also asked to indicate how great an importance they had placed on performing the PM task successfully when presented with it initially. Further to this, the participants were questioned about the reasons for responding later than five minutes after receiving the text. This question was presented in order to ensure that it was not the case that a participant remembered to respond to the text message but did not have the opportunity to do so (e.g., they were already on the 'phone or in an area

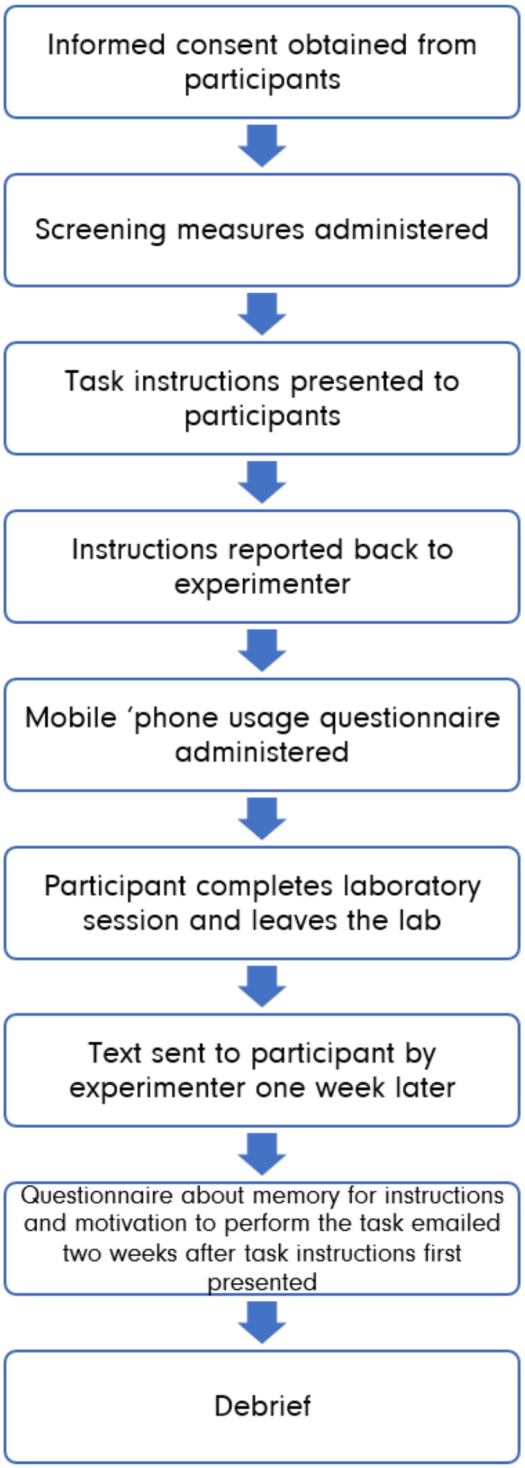

Figure 1: A schematic of the study design.

with intermittent signal reception). Finally, the participants were asked to estimate how many times they had thought about the task in the intervening week since forming the intention to respond to the text. The participants returned the answers to the experimenter via email.

The participants were debriefed at the end of the study. Given the multistage nature of the study design, a schematic overview is presented in Figure 1.

Results

Mobile 'phone usage questions

None of the participants in either group reported experiencing long periods when they did not have credit on their mobile 'phone.

There were no group-related differences in self-reported competence in placing missed calls, $t(49) < 1$, $p = .530$, sending and receiving text messages, $t(49) < 1$, $p = .357$, or making calls in response to text messages, $t(49) < 1$, $p = .395$. The group mean responses to each question are displayed in Table 2.

Table 3 shows the self-reported frequency of mobile 'phone checking by the two groups. The majority of participants from both groups reported that they checked their 'phone more than 10 times a day. There was no association between participant group and frequency of 'phone checking, $\chi\ 2(2, N = 51) < 1$, $p = .664$.

Table 2: Group mean rated competence levels in response to the mobile 'phone use questionnaire items. Standard deviations in parentheses.

	Group with dyslexia (N = 26)	Group without dyslexia (N = 25)
Placing missed calls	9.62 (1.02)	9.76 (0.52)
Sending and receiving text messages	9.88 (0.43)	9.76 (0.52)
Making a 'phone call in response to a text message	9.81 (0.49)	9.64 (0.86)

Table 3: Frequency of self-reported mobile 'phone checking by each participant group

	Group with dyslexia (N = 26)	Group without dyslexia (N = 25)
Once a week	0	0
Once every few days	0	0
Once a day	0	0
Between two and four times a day	2	1
Between five and 10 times a day	6	4
More than 10 times a day	18	20

Prospective memory response

Three participants (one without dyslexia and two with dyslexia) who took longer than two hours to respond to the text message were deemed to have forgotten about the PM task at the point at which it was relevant to respond.

There was a significant association between participant group and response type, $\chi 2(1, N = 51) = 4.25$, $p = .039$. Adults with dyslexia were more likely not to perform the PM response than to perform it, whilst individuals without dyslexia were more likely to perform the PM task and less likely not to carry it out. The frequency counts for the two participant groups are shown in Figure 2.

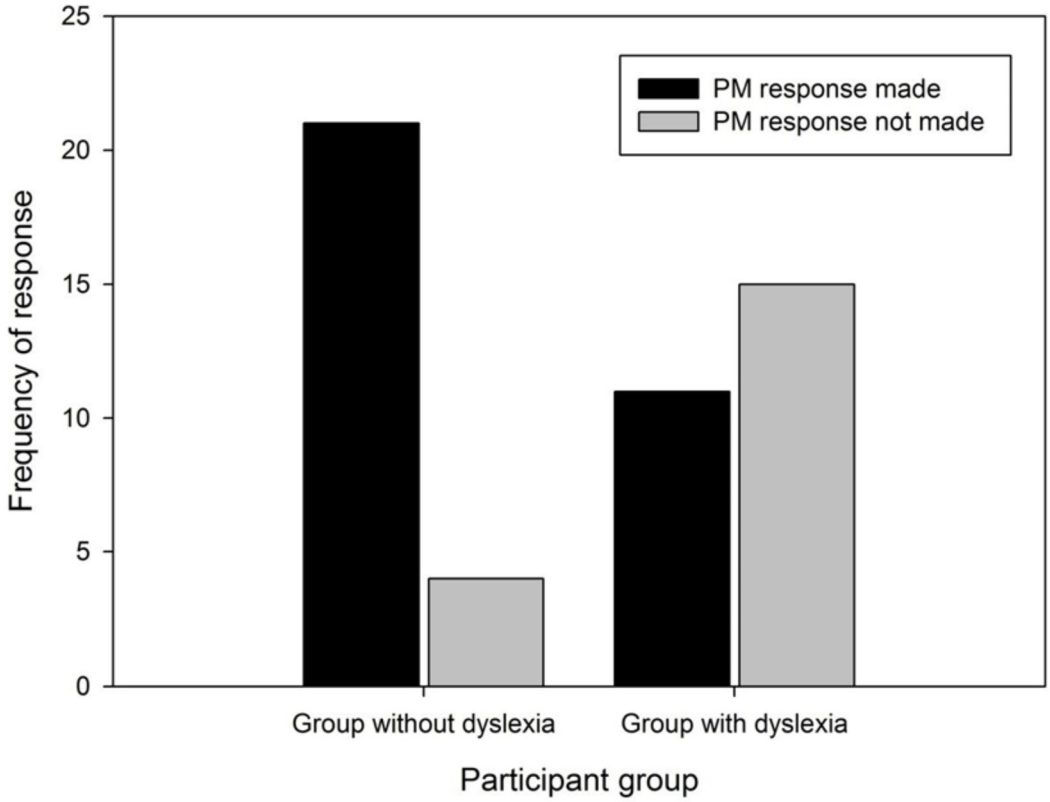

Figure 2: Group EBPM responses.

Questionnaire about PM responses

Overall, there was a 92% response rate to the email questionnaire. A significant association was found between participant group and the frequency with which remembering the PM instruction successfully was reported, Fisher, p = .023. More of the adults with dyslexia reported failing to remember the instruction rather than remembering it. Conversely, the adults without dyslexia were more likely to report remembering the instruction rather than to report forgetting it. The observed frequencies for the Fisher's exact test are displayed in Table 4.

With regard to the self-reported level of importance placed on performing the PM task, the two groups gave similar ratings (group with dyslexia: mean = 7.61, SD = 2.86; group without dyslexia: mean = 7.83, SD = 2.04). An unrelated t-test indicated that there was no significant group difference in the level of importance that the participants attached to performing the EBPM task successfully, t(44) = .297, p = .768.

On average, the group with dyslexia (mean = 5.39, SD = 2.02) reported themselves as having thought about the PM task on rather fewer occasions over

Table 4: Self-reported group frequencies of having remembered the PM instruction over the one-week interval

Response	Participant group	
	Without dyslexia (N = 23)	With dyslexia (N = 24)
Remembered	22	16
Did not remember	1	8

the course of the week than the participants without dyslexia (mean = 6.35, SD = 1.64). However, an unrelated t-test indicated there to be no significant group difference, $t(44) = 1.76$, $p = .085$.

Discussion

Adults with dyslexia were less successful than adults without dyslexia at remembering to perform the naturalistic EBPM task. However, their lowered EBPM performance over a one-week interval cannot be explained in terms of differences in either competency with mobile 'phone use or motivation to perform the task successfully; no differences were found in self-report measures tapping either of these factors. In contrast, group differences were found when the participants were asked to report whether or not they had remembered the PM task instructions. Fewer adults with dyslexia reported remembering the task instructions when questioned after receiving the text message. The group with dyslexia also reported thinking about the PM task fewer times over the course of the week leading up to the PM response but this result was not statistically significant.

All of the participants in both groups were able to report the task instructions back to the experimenter immediately after they had been presented, suggesting that the initial encoding and understanding of this verbal material was not impaired in the group with dyslexia. Instead, it would seem more likely that problems with remembering the instructions occurred later – in terms of either retaining a strong long-term memory trace (for instance, by rehearsing the instructions mentally on occasion over the intervening period) or accessing them efficiently at the time that they were required. Given that no group difference was found in the participants' estimates of how often they had thought about the PM task over the course of the week between forming the intention and receiving the text that required the PM response, the latter explanation seems more likely to the authors. Thus, the results of the current study suggest that EBPM problems in dyslexia are related to the retrospective rather than the prospective component of PM (e.g., Einstein & McDaniel, 1996).

On the basis of the current findings, dyslexia-related problems with PM would seem to extend to EBPM at greater delay intervals between forming an intention to act and having the opportunity to do so. The results, thus, provide a more nuanced understanding of how EBPM can be affected by dyslexia. Rather than EBPM being unaffected by dyslexia, there are some circumstances under which EBPM failure may occur. It would thus seem that there is no simple dichotomy between impaired TBPM and unaffected EBPM; instead, successful performance is dependent on task demands and the conditions prevailing at recall. This is an important point and should be fed into the support of people with dyslexia, when setting up provision for them in educational or workplace contexts.

Given that there was a week's unsupervised interval between intention formation and execution, it was impossible to ensure that the participants did not use external memory aids after leaving the laboratory. Instead, the honesty of the participants in complying with the task instructions had to be relied upon. If anything, however, it would be expected that the group with dyslexia would be more likely to use such aides-memoire to facilitate PM, since adults with dyslexia have self-reported more frequent use of such tools and strategies (Smith-Spark et al., in press). Despite the possibility that they may have used more external props to support PM, then, the group with dyslexia still performed worse than the group without dyslexia.

To conclude, EBPM was explored in the current paper in a study which required a response to be made under more naturalistic conditions after a delay of one week. The results indicate that EBPM deficits can be found in adults with dyslexia when there is a longer delay between forming an intention and being able to act upon it and when the task is episodic in nature. These problems may arise over longer delay intervals from a reduced ability to access verbal information in long-term memory at the point at which it is required. Further work is required to tease apart the relative contributions of the retrospective and prospective components of PM to reduced PM accuracy in dyslexia but, based on the current study, it seems likely that dyslexia-related EBPM deficits (at least) arise from a reduced ability to access task-relevant information in verbal long-term memory at the point at which it is required.

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