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# Self-reports of increased prospective and retrospective memory problems in adults with developmental dyslexia

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Abstract

Short-term and working memory problems in dyslexia are well-documented but other memory domains have received little empirical scrutiny, despite some evidence to suggest that they might be impaired. Prospective memory is memory for delayed intentions, whilst retrospective memory relates to memory for personally experienced past events. To gain an understanding of subjective everyday memory experience, a self-report measure designed to tap prospective and retrospective memory was administered to 28 adults with dyslexia and 26 IQ-matched adults without dyslexia. Adults with dyslexia reported experiencing significantly more frequent problems with memory than the adults without dyslexia. Group differences were found across seven out of the eight questionnaire scales. Further to these analyses, the participants' own ratings were compared with proxy-ratings provided by close associates. The perception of poorer memory abilities in the participants did not differ between respondent types. The self-reported difficulties are, thus, unlikely to be the result of lowered self-esteem or metacognitive awareness. More frequent difficulties with both types of memory would seem, therefore, to be experienced by adults with dyslexia in everyday life. Further laboratory-based research is recommended to explore both memory domains in dyslexia and to identify the cognitive mechanisms by which these problems occur.

Keywords: Developmental dyslexia; adults; prospective memory; retrospective memory; Prospective and Retrospective Memory Questionnaire

# Self-reports of increased prospective and retrospective memory problems in adults with developmental dyslexia

Developmental dyslexia (henceforth, dyslexia) is a learning disorder characterized by persistent difficulties with either reading or spelling, or both (e.g., Lyon, Shaywitz & Shaywitz, 2003; Siegel, 2006; Vellutino, Fletcher, Snowling & Scanlon, 2004). Whilst the study of dyslexia has, understandably, been dominated by research and theories to explain these problems in terms of phonological processing deficits (for reviews, see Castles & Friedmann, 2014, and Vellutino et al., 2004), there are other areas of cognition in which individuals with dyslexia also show impairments (for a recent meta-analysis, see Kudo, Lussier & Swanson, 2015). Memory is one such area, with dyslexia-related differences being well documented in both children and adults in short-term and working memory (e.g., Fischbach, Könen, Rietz & Hasselhorn, 2014; Jeffries & Everatt, 2004; Jorm, 1983; Menghini, Finzi, Carlesimo & Vicari, 2011; Palmer, 2000; Smith-Spark, Fisk, Fawcett & Nicolson, 2003; Smith-Spark & Fisk, 2007; Swanson, 1992, 1999). However, other memory systems have not received anywhere near the same level of empirical scrutiny. Two such neglected memory systems are those of prospective memory (PM) and retrospective memory (RM), with evidence being particularly lacking for both memory systems in the case of adults with dyslexia. To extend the small amount of literature available, the research reported in the current paper explored the relative day-to-day frequency of PM and RM failures in adults with and without dyslexia, using a self-report questionnaire.

Prospective memory is memory for delayed intentions (e.g., Winograd, 1988) or remembering to remember (Mäntylä, 1994). It requires the successful function of two key memory components, a prospective (or planning) component to recall the intention at the appropriate point in time and a retrospective component to remember the nature of the intention

itself (Einstein & McDaniel, 1990, 1996). Further to this division, there are two main types of PM and these make different demands on an individual's cognitive resources (e.g., McDaniel & Einstein, 2007). Event-based PM (EBPM) tasks require the individual to remember to perform a particular intention in response to the occurrence of a particular event; for example, remembering to give a message to a colleague when he or she is next encountered. With this type of task, the individual is able to use cues in the environment to guide behaviour (such as meeting the colleague in the corridor which acts as a cue to give the message). Cues embedded in the environment do not require internal retrieval processes in order to be remembered successfully but, instead, can just "pop out" at the individual and trigger the PM intention. Conversely, time-based PM (TBPM) tasks demand that the individual remembers to perform a particular action at a particular time in the future; for example, remembering to return a call in an hour's time. Time-based performance is argued to be more self-initiated than EBPM (e.g., Einstein, McDaniel, Richardson, Guynn & Cunfer, 1995; although see Huang, Loft & Humphreys, 2014, and Oksanen, Waldum, McDaniel & Braver, 2014 for recent evidence against this argument), working in the absence of external cues or prompts and requiring the individual mentally to drive the process of ensuring that the intention is enacted successfully (by, for example, making regular, strategic clock checks).

A number of lines of evidence suggest that people with dyslexia will have problems with PM. There are anecdotal reports of greater levels of forgetfulness being associated with dyslexia (e.g., Augur, 1985). In support of this, a 14-day diary study by Smith-Spark (2000), in which adult participants logged their failures in everyday memory, found significantly higher reports of forgetfulness in adults with dyslexia compared with an age- and IQ-matched control group. A substantial proportion of those recorded acts of forgetfulness were prospective in nature, such as

forgetting to post a letter as intended or forgetting the purpose behind moving from one room to another. In addition, reports of problems with planning (e.g., Levin, 1990; Torgeson, 1977) would also suggest more frequent errors in PM in dyslexia.

As well as problems with temporal sequencing (e.g., Miles, 1982; Wolff, Michel, Ovrut & Drake, 1990), differences in time perception have also been reported in dyslexia (e.g., Bruno & Maguire, 1993; Khan, Abdal-hay, Qazi, Calle & Castillo, 2014; Klein, 2002; Nicolson, Fawcett & Dean, 1995; Tallal, 1980; Wolff, 2002). Problems in both these areas are likely to have an impact on PM. Whilst there is only a small, and rather contradictory literature on the role of time perception in TBPM (Mackinlay, Kliegel & Mäntylä, 2009; McFarland & Glisky, 2009), such that its strongest predictive relationship has been reported to be with time monitoring rather than PM accuracy (Labelle, Graf, Grondin & Gagné-Roy, 2009; Mioni & Stablum, 2014), dyslexia-related problems with time perception may have an influence on TBPM.

Further indirect evidence to suggest PM problems in dyslexia comes from the relationsup between PM and working memory, the memory system required for the temporary storage and processing of information (e.g., Baddeley, 1986). Working memory has been found to be positively related to PM performance (e.g., Einstein, McDaniel, Manzi, Cochran & Baker, 2000; Einstein, Smith, McDaniel & Shaw, 1997; Marsh & Hicks, 1998; Smith, Persyn & Butler; 2011; although Schnitzspahn et al., 2013 failed to find a predictive relationship). Basso, Ferrari, and Palladino (2010) have argued that whilst WM and PM are distinct memory processes, PM would appear to be reliant on WM resources under high task demands (see also Ward, Shum, McKinlay, Baker-Tweney & Wallace, 2005). Given that impairments in working memory are a defining characteristic of dyslexia (e.g., Booth, Boyle & Kelly, 2010; McLoughlin et al., 1994), it may well be that difficulties in this domain will also play out in an increased susceptibility to

failures in PM. Further to this, Nicolson and Fawcett (1990) have argued that dyslexia-related deficits are more likely to emerge when task demands are high or there are other stressors on performance (such as dual-task conditions, fatigue, or time pressure). From this perspective, PM deficits would be expected to emerge when task conditions were such as to make greater demands on cognitive resources, such as attention.

Finally, and most directly, adults with dyslexia have been found to have difficulties on laboratory and naturalistic TBPM tasks relative to age- and IQ-matched controls (Smith-Spark, Zięcik & Sterling, 2016). On the laboratory task, the participants with dyslexia performed worse than the controls regardless of the demands made on working memory during performance of the ongoing task in which the TBPM responses were embedded. As well as being less accurate, they also made less use of the clock available to them to check the time. Whilst these findings indicate poorer PM in adults with dyslexia, they do not give an insight into how widely such problems pervade the day-to-day lives of those with the condition.

Taken together, these various lines of evidence indicate that dyslexia is likely to have an everyday impact on the ability to execute an intention successfully at a future point. Furthermore, self-report data from adults with dyslexia have also suggested that problems with PM might be evident in daily life. Smith-Spark, Fawcett, Nicolson, and Fisk (2004) investigated everyday cognitive failures in adults with dyslexia using a self-report questionnaire, the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald & Parkes, 1982). They found that there was, overall, a greater reported incidence of cognitive failures in the day-to-day lives of their participants with dyslexia. More particularly, several of the questions making up the CFQ could very plausibly be argued to tap PM (Smith, Della Sala, Logie & Maylor, 2000). Significant group differences were found by Smith-Spark et al. on two out of three of these questionnaire

items. More recently, Leather, Hogh, Seiss, and Everatt (2011) have also found an increased self-reported susceptibility to cognitive failures in adults with dyslexia on the CFQ.

Despite the importance of PM to everyday life (e.g., McDaniel & Einstein, 2007), there is only one extant study of PM in dyslexia in day-to-day situations (Khan, 2014). Khan used the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith et al., 2000) to explore PM (and RM) in children with dyslexia, finding evidence of impairments across both memory systems. However, his study did not match the participant groups for IQ nor were diagnostic criteria for inclusion reported. Moreover, the children in his study spanned seven school years, meaning that there is likely to be considerable variation between the participants in the opportunities for independently exercising their PM abilities. The relative age of the children with and without dyslexia is not clear from the paper, meaning that it is difficult to gauge the relative opportunities for independent PM. The PRMQ is also designed for use with adults rather than children and its questions may well be less applicable to children than they are to adults. Given that more demands are placed on PM in adulthood than in childhood (where parents tend to do most of the future thinking for their young offspring, e.g., Hayne et al., 2011, acting as a kind of external memory; cf. Clark & Chalmers, 1998; Spurrett & Cowley, 2010), it is particularly important to explore PM in adults with dyslexia rather than simply extrapolate from the results obtained with children. As McLoughlin, Fitzgibbon, and Young (1994) have argued, adults with dyslexia are not simply children with dyslexia "grown up" (p. 1) but, instead, have their own unique set of challenges and demands on their cognition. There is, thus, a need to explore their cognition in its own right, especially in areas which impinge directly on life satisfaction and opportunities. Memory is clearly one such area. There are potentially serious

repercussions for an adult's employment or personal life were memory to go awry on a frequent basis when performing everyday personally relevant tasks (e.g., McDaniel & Einstein, 2007).

Retrospective memory (RM) refers collectively to memory for personally experienced past events, semantic memory, and memory for word lists (e.g., Smith et al., 2000). There is a small literature relating to RM in dyslexia. As mentioned previously, Smith-Spark's (2000) diary study indicated that there was a greater propensity to forgetfulness in everyday life in adults with dyslexia. As well as the PM failures already highlighted in this section, there were also many lapses of memory which were retrospective in nature, such as forgetting where items had been left or forgetting that a relative was out of the country and trying to telephone him on his home telephone number.

Laboratory-based work also points towards dyslexia adversely affecting RM, although the evidence comes mainly from studies involving children and, usually, with a minimal delay between encoding and the opportunity for retrieval. Nelson and Warrington (1980) found evidence for poorer recognition memory for words in children with dyslexia but not for unfamiliar faces, with recognition judgements being made after 40 intervening stimuli in both tasks. McNamara and Wong (2003) presented two tasks involving RM to a group of children with learning disabilities, some of whom were children with dyslexia. The first of these involved the retrospective recall of a dance episode five weeks after it had been witnessed, whilst the second required the description of the procedure involved in borrowing a library book. The authors found that the children with learning disabilities were poorer at recalling everyday information on both tasks. Further to this, Menghini, Carlesimo, Marotta, Finzi, and Vicari (2010) have presented evidence for explicit memory deficits across the phonological and visuospatial domains in children with dyslexia, with retrospective recall being tested

immediately after the presentation of item lists. Huestegge, Rohrβen, van Emingen-Marbach, Pape-Neumann, and Heim (2014) presented complex abstract figures to children with dyslexia and IQ-, age-, and gender-matched controls when tested 45-60 minutes later. Whilst the overall accuracy of visual-long term memory was comparable between the groups, the children with dyslexia produced significantly more detail-related errors. Less direct evidence, based on differences in age of acquisition effects between adults with and without dyslexia, also suggests that there may be subtle differences in the way that information is either encoded, represented, or accessed in long-term memory in dyslexia (Smith-Spark & Moore, 2009).

The evidence, therefore, suggests that adults with dyslexia are likely to experience more problems with PM and RM in everyday life but this has not been directly tested. To gain an initial understanding of the potential impact of dyslexia on the frequency with which memory problems are experienced in day-to-day life, a self-report questionnaire was administered to adults with and without dyslexia. The PRMQ (Smith et al., 2000) is designed to investigate the frequency of memory failures related to both PM and RM in everyday life. It has been quite widely used to assess memory, having been administered for example, to people with Alzheimer's disease (Smith et al., 2000), binge drinkers (Heffernan & O'Neill, 2012), individuals with multiple sclerosis (West, McNerney & Krauss, 2007), smokers (Heffernan, O'Neill & Moss, 2010), and people with schizophrenia (Chan et al., 2008). Crawford, Henry, Ward and Blake (2006) have proposed that the PRMQ has a potential advantage over other self-report memory scales, in that it measures the constructs of RM and PM systematically over a range of different contexts. The PM and RM measures are further subdivided into questions which probe either short-term or long-term retention intervals. These retention interval categories subdivide further into self-cued and environmentally-cued types.

In addition to collecting self-report data from the participants themselves, memory ratings in the present study were also collected from close associates of the respondents. The proxy-rating PRMQ (Crawford et al., 2006) was developed to allow the ratings provided by respondents to be corroborated by people who are in close contact with them. Whilst proxy-ratings are likely to be most important when seeking to corroborate the self-ratings of clinical populations, the use of the proxy-rating PRMQ in the current study allowed a means of determining whether or not any reports of higher frequencies of PM failures in the group with dyslexia were due solely to negative self-perceptions. Given that self-esteem problems are carried by many people with dyslexia into adulthood (e.g., Alexander-Passe, 2006; McNulty, 2003; Riddick, Sterling, Farmer & Morgan, 1999), this was deemed an important check to perform. Smith-Spark et al. (2004) have previously used a similar method, administering the CFQ-for-others (Broadbent et al., 1982) to close associates of adults with dyslexia and finding supporting evidence for the self-reports of the CFQ respondents. Unlike the CFQ-for-others, the proxy-rating PRMQ uses the same set of questions as the PRMQ and is, thus, likely to be even more effective in indicating differences in the perceptions of the incidence of memory failure by participants and those in close contact with them. The participants were, therefore, asked to pass on a proxy-rating version of the PRMQ (Crawford et al., 2006) to a close friend or relative to complete on their behalf.

In line with the evidence for dyslexia-related impairments in RM (Huestegge et al., 2014; McNamara & Wong, 2003; Menghini et al., 2010; Smith-Spark, 2000) and PM (Khan, 2014; Smith-Spark, 2000; Smith-Spark et al., 2004, 2016), it was predicted that both RM and PM failures would be more frequently reported by adults with dyslexia than by an age- and IQ-matched control group of adults without dyslexia. It remained to be seen whether group

differences would be found across all eight scales making up the PRMQ (Smith et al., 2000) or whether self-reported problems would be specific to particular scales.

Previous use of proxy-rating questionnaires (Smith-Spark et al., 2004) has indicated that ratings of everyday memory by the close associates of adults with and without dyslexia are consistent with those provided by the respondents themselves. Evidence supporting the self-reports of the PRMQ respondents was, therefore, predicted to emerge from the proxy-ratings.

## Method

### Participants

A total of 54 native English-speaking university students took part in the study, all of whom were aged between 18 and 35 years. The participants received course credit or a small honorarium for taking part. The participants comprised two groups, a group with dyslexia (N = 28, 5 males, 23 females) and a group without dyslexia (N = 26, 6 males, 20 females). There was no significant difference in age between the two participant groups. Table 1 shows the mean ages of the two groups, together with the descriptive and inferential statistics for the screening measures also described in this section.

TABLE 1 ABOUT HERE

All of the participants in the group with dyslexia had been diagnosed by an educational psychologist and showed the experimenter a report to confirm this diagnosis. None of the control participants reported experiencing difficulties with literacy when asked prior to testing. Whilst self-reports of not having dyslexia have been found to be highly accurate (Nicolson & Fawcett, 1997), measures sensitive to reading and spelling problems were nevertheless administered to all participants in order to further validate the participant groupings.

Reading ability was measured using the Nonsense Word Reading Passage (NWR) from the Dyslexia Adult Screening Test (DAST; Fawcett & Nicolson, 1998). This test required the reading of a short passage which contained both real words and orthographically legal nonsense words. The task of decoding novel nonwords is difficult even for adults with dyslexia whose reading is otherwise compensated (Brachacki, Fawcett & Nicolson, 1994; Finucci, Guthrie, Childs, Abbey & Childs, 1976), making it a powerful indicator of the continued impact of dyslexia on literacy in adulthood. The accuracy and the speed with which the DAST NWR were completed were combined to form a composite measure of reading performance, with scoring penalties being incurred for particularly slow or inaccurate reading. All of the participants in the group without dyslexia scored above the normative age-specific cut-off point for identifying an individual as being "at risk" of dyslexia. Further to this, the DAST NWR scores of the participants with dyslexia were significantly lower than those of the group without dyslexia.

Spelling ability was assessed using the Wechsler Objective Reading Dimensions (WORD; Wechsler, 1993). The participants were presented with a series of words to spell which increased in difficulty. In line with the standardized administration of the task, the word to be spelled was spoken aloud by the experimenter, followed by a sentence containing the word to set it in context, and then the word itself was repeated. Testing was terminated after six successive incorrect responses. On average, the group with dyslexia spelled significantly fewer words correctly than the control group on the WORD. A raw score of 42/50 or greater equated to a spelling age of greater than 17 years (ceiling on the task) and thus placed the speller in the typical adult range. Nineteen of the participants with dyslexia had WORD spelling ages of less than 17 years, whilst all of the participants in the control group obtained spelling ages of greater than 17 years.

A short-form IQ score was calculated based on four subscales of the Wechsler Adult Intelligence Scale- Fourth UK Edition (WAIS-IV; Wechsler, 2010), using the method set out in Turner (1997). The four subscales chosen (Verbal Scale: Comprehension and Vocabulary; Performance Scale: Block Design and Picture Completion) are not sensitive to the presence of dyslexia and, thus, provide a means of comparing IQ that is independent of the effects of dyslexia. There was no significant difference in short-form IQ between the two participant groups. All participants obtained short-form IQ scores of ≥ 90, the criterion for inclusion.

Materials

The PRMQ (Smith et al., 2000) consisted of 16 items which required the participants to rate the frequency with which memory error occurred in day-to-day life. The reliability of the PRMQ is good, with Crawford et al. (2003) reporting a Cronbach's α-value of .89 for PRMQ overall total score and Cronbach's α-values of .84 and .80 for the PM and RM scales respectively. Responses to each question were made by means of a five-point scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Quite Often, 5 = Very Often). Higher scores therefore indicated more frequent problems with memory function. Two PRMQ questions probed each possible permutation of memory type (RM vs. PM), delay-type (short vs. long), and cue-type (self-cued vs. environmentally-cued). These permutations formed eight PRMQ scales, scores on which were the mean response to the two questions constituting that particular scale.

Delay type related to the interval between the formation of a memory and the point at which it needed to be accessed successfully. The short-term PM items probed situations where the memory needed to be stored for a brief period of time before the opportunity for recall of the intention occurred (e.g., five or 10 minutes). Long-term PM items, on the other hand, addressed situations where a particular memory needed to be accessed after a much longer period of time

(e.g., a week). In the case of the RM items, differing retention intervals were tapped by asking questions about failures of memory for personally experienced events over short periods of time (e.g., keeping track of characters from scene to scene in a television programme) or over days (e.g., recounting the same story to the same person on a number of different occasions).

Questions were also split between two different types of recall cue, namely self- and environmentally-cued memory. Self-cued PM related to intentions which the individual had to remember to act upon without external reminders (such as intending to do something in a few minutes or remembering to return a telephone call). Environmentally-cued types were represented by intentions such as remembering to perform an action with an object that was in immediate view. In such cases, the memory should have been cued by an external object which served to act as a reminder. Self-cued RM cues were probed by questions asking about the frequency with which things are forgotten that the individual had, for example, done or been told. Environmentally-cued RM cues related to features of the environment triggering a memory; for example, an individual reading a passage of text yet failing to realize that he or she had only recently read the very same section of prose.

The wording of the introduction, questions, and rating scale of the proxy-rating PRMQ differed from the PRMQ only in that the relatives or close friends of the participants were asked to rate the memory abilities of the close friend or relative (explicitly named in the printed task instructions) from whom the questionnaire was received (see Crawford et al., 2006).

## Design

The analyses took two forms. Firstly, a one-way multivariate analysis of variance (MANOVA) was used to analyze the responses of the participants themselves at the level of the eight individual PRMQ scales. Participant group (with dyslexia and without dyslexia) was

entered as the between-subjects factor. The eight scale scores were entered into the analysis as dependent variables.

Secondly, in order to ascertain whether respondents and those in very frequent contact with them viewed their memory abilities in a similar way, total scores for the RM and PM scales on the PRMQ and the proxy-rating PRMQ were converted to *T*-scores, using the method set out in Crawford, Smith, Maylor, Della Sala and Logie (2003; see also Crawford et al., 2006), thus allowing comparison on a common measure. The *T*-scores were then converted to estimated true scores to permit a direct comparison of ratings between the two types of respondents (Crawford et al., 2006). This conversion meant that higher scores reflected better memory performance (with 50 being the mean and the SD being 10). A three-way mixed-measures analysis of variance (ANOVA) was performed on the estimated true scores, with participant group (with dyslexia and without dyslexia) entered as the between-subjects factor. Respondent type (respondent and proxy-respondent) and memory type (RM and PM) were entered as the within-subjects factors. However, whilst this analysis has the benefit of allowing a determination of whether close associates of the respondents view their memory in the same way as the respondents themselves, it should be noted that some of the fine-grained detail is lost in converting the raw scores to *T*-scores, since the individual PRMQ scales are not considered under Crawford et al.'s method. This loss of detail precipitated the need for two separate analyses to be presented, one at the level of the individual scale scores for the participants themselves, and the other permitting a check of the validity of the participants' responses by comparing them with those of their close associates, albeit at a coarser-grained level of analysis.

Procedure

Informed consent was acquired from all of the participants prior to testing. Background information about the participants was collected before the administration of the short-form IQ and literacy measures. After these had been presented, the participants were asked to fill out the questionnaire. The participants were informed that the questions were about minor memory mistakes which everyone makes from time to time, but that some of these mistakes occur to people more often than others. The participants were then asked to indicate how often they felt that a particular type of memory failure had happened to them by ticking the appropriate point on the five-point scale. They were instructed to answer all of the questions even if they did not seem entirely applicable to their situation. A debriefing followed the completion of the questionnaire.

Prior to leaving the laboratory, the participants were given a questionnaire to pass on to a close friend or relative to complete. The proxy respondents were asked to return their completed questionnaire using a stamped addressed envelope provided by the researcher.

## Results

### Reliability analysis

The reliability of the PRMQ was high (for responses by the participants themselves to all 16 questionnaire items, Cronbach's $\alpha = .94$; for the eight PM items, Cronbach's $\alpha = .91$; for the eight RM items, Cronbach's $\alpha = .85$).

### The PRMQ scales

Independent-samples *t*-tests indicated that the adults with dyslexia rated themselves as significantly more prone to memory failure on the PRMQ total, RM total, and PM total scores. Descriptive and inferential statistics are shown in Table 2.

TABLE 2 ABOUT HERE

The one-way MANOVA performed on the PRMQ scales indicated that there was a significant multivariate effect of participant group on the self-reported frequency with which memory errors were experienced, Wilks' $\Lambda = .628$, $F(8, 45) = 3.33$, $p = .005$, $\eta_p^2 = .372$. The participants with dyslexia rated themselves as more frequently prone to memory errors than the participants without dyslexia on each of the eight PRMQ scales. Follow-up univariate *F*-tests indicated significantly more frequent memory problems for the group with dyslexia on seven of the scales. After applying Bonferroni corrections (which resulted in an adjusted α-level of .006), the group difference in raw scores on the retrospective long-term environmentally-cued scale was reduced to below statistical significance. Group descriptive statistics for each PRMQ scale are presented in Table 3, together with the univariate *F*-test results.

TABLE 3 ABOUT HERE

Comparison of PRMQ and proxy-PRMQ estimated true scores

Descriptive statistics for the estimated true scores are presented in Table 4.

TABLE 4 ABOUT HERE

The estimated true scores indicated that the adults with dyslexia were rated as significantly more prone to memory error than the adults without dyslexia, $F(1, 48) = 31.88$, $MSE = 134.019$, $p < .001$, $\eta_p^2 = .399$.

There was no significant difference between the estimated true scores of the respondents and those of the proxy-respondents, $F(1, 48) = 2.25$, $MSE = 93.073$, $p = .140$.

Estimated true scores for RM were significantly lower than those for PM, $F(1, 48) = 17.00$, $MSE = 25.035$, $p < .001$, $\eta_p^2 = .262$.

There was no significant two-way interaction between participant group and respondent type, $F(1, 48) = 1.66$, $MSE = 93.073$, $p = .204$, nor between participant group and memory type, $F(1, 48) < 1$, $MSE = 25.035$, $p = .481$.

There was, however, a significant respondent type x memory type interaction, $F(1, 48) = 19.72$, $MSE = 42.268$, $p < .001$, $\eta_p^2 = . 291$. A post hoc *t*-test indicated no significant difference in the estimated true scores for PM (mean = 45.19, $SD = 11.23$) and RM (mean = 46.22, $SD = 9.45$) by the PRMQ respondents, $t(53) < 1$, $p = .381$. However, in the case of the proxy-respondents, estimated true scores for RM (mean = 42.62, $SD = 10.68$) were significantly lower than those for PM (mean = 50.98, $SD = 9.75$), $t(49) = 6.85$, $p < .001$, $d = 0.97$.

There was no significant participant group x respondent type x memory type interaction, $F(1, 48) < 1$ , $MSE = 42.268$, $p = .368$.

## Discussion

Adults with dyslexia perceived themselves as experiencing everyday problems with memory significantly more frequently than age- and IQ-matched adults who do not have dyslexia. These difficulties were manifested in terms of more frequently reported problems overall and for both the RM and PM scales. At a finer-grained level, more frequent memory difficulties were reported on seven of the eight PRMQ scales. The findings are consistent with anecdotal reports (e.g., Augur, 1985) and diary reports (e.g., Smith-Spark, 2000) of increased forgetfulness in dyslexia and also weaker abilities to retain episodic details in memory (Huestegge et al., 2014; McNamara & Wong, 2003; Menghini et al., 2010). Moreover, the results supplement and extend previous self-report questionnaire data indicating problems with everyday memory (Khan, 2014; Leather et al., 2011; Smith-Spark et al., 2004), highlighting self-identified problems in two distinct memory domains. Both RM and PM are theoretically well-

defined and have mature methodologies designed to tap into their component processes, rather than the more theoretically amorphous "cognitive failures" of Broadbent et al.'s (1982) CFQ, wherein a range of memory and attentional processes have to be drawn upon to explain these failures (e.g., Pollina, Greene, Tunick & Pluckett, 1992).

The greater problems with RM self-reported by the group with dyslexia would seem to support the findings of Smith-Spark (2000) in adults and those of McNamara and Wong (2003) in children. Retrospective memory would appear to be reduced in dyslexia and this should be explored in greater depth using objective measures of performance. Given the paucity of the literature on episodic memory in dyslexia, greater consideration of these results is outside the scope of this section.

In finding a greater frequency of memory error in everyday life in adults with dyslexia, the results are consistent with Khan's (2014) use of the PRMQ with children. However, the effect sizes found in the current study are considerably larger than those reported by Khan, most likely due to more stringent screening measures being taken and the PRMQ being administered to its target population of adults rather than children. Moreover, the self-reports and ratings provided by close associates of the respondents did not differ on either the PM or RM scales. The corroborative evidence of a greater susceptibility to memory problems provided by the proxy-PRMQ respondents would appear to rule out lowered self-esteem in dyslexia (e.g., Alexander-Passe, 2006; McNulty, 2003; Riddick et al., 1999) or poorer metacognitive awareness as alternative explanations for the findings.

As a whole, the proxy-ratings supported the responses of the PRMQ respondents, indicating significantly more frequent problems with both PM and RM in the group with dyslexia. However, there was a significant respondent type by memory interaction, in which

failures of RM were rated as occurring significantly more often than failures of PM by the proxy-rating respondents. This may reflect more frequent exposure to situations involving failures of RM; failures of PM may be more privileged to the respondent and more diffused over individuals and settings, meaning that they are less frequently evident to others.

A general problem with self-reported measures of memory is that they do not always correlate highly with objective memory tests and clinical observations (Craik, Anderson, Kerr & Li, 1995). Just such an equivocal picture emerges from studies of the relationship between PRMQ responses and direct observations. On the one hand, Kliegel and Jager (2006) have reported that the PM subscale of the PRMQ was a significant predictor of TBPM performance and was close to significance in predicting EBPM performance under laboratory conditions. Kliegel and Jager's results also provide further support for Crawford et al.'s (2003) argument in favour of the multidimensional nature of the PRMQ since neither PRMQ total score nor the RM subscale were found to predict objective laboratory measures of PM performance. On the other hand, Uttl and Kibreab (2011) found that the PRMQ did not significantly correlate with a number of EBPM laboratory tasks nor with a naturalistic TBPM task. Chan et al. (2008) have also reported no correlations between the PRMQ and computerized EBPM and TBPM tasks.

There is some evidence to suggest that the PRMQ, like other self-report questionnaires, is vulnerable to some criticism over its validity and, therefore, the group differences self-reported on the PRMQ may not actually be evident when investigated objectively. In a review of the reliability and validity of the PRMQ across six publications, Uttl and Kibreab (2011) argue for a unidimensional structure and a lack of divergent validity. However, several studies (Crawford et al., 2003; Macan, Gibson & Cunningham, 2010; Mäntylä, 2003; Ronnlund, Mäntylä & Nilsson, 2008) have supported a tripartite structure, consisting of general memory, RM, and PM. Indeed,

Crawford et al. (2006) argue that the PRMQ should be used in conjunction with observations and clinical measures. Nevertheless, the results of the proxy-rating PRMQ would seem to mitigate, to a degree, against this concern over the validity of the PRMQ. At the very least, differences in everyday PM seem to be observable to both respondents and their close associates. Beyond this, the self-report questionnaires and objective tasks measure different levels of cognition. Stanovich (2009) has highlighted the difference between the reflective level of cognition (which relates to goals, beliefs about those goals, and choices of action which best fit those goals and beliefs) and the algorithmic level (which relates to information processing mechanisms). Self-report questionnaire measures are likely to tap the reflective level (and, thus, typical, everyday performance), whilst laboratory tasks probe the algorithmic level (under which participants are expected to perform optimally on a specific task under laboratory conditions). Under this view, both types of measure are important in obtaining a comprehensive view of cognition.

Whilst the PRMQ finding are useful in highlighting the increased problems which adults with dyslexia feel that they experience with memory in everyday life, they do not indicate the underlying cognitive mechanisms responsible.

As stated in the Introduction, all PM tasks contain a retrospective as well as prospective component, in that the individual must remember the content of the intention at the time of remembering to perform it (Einstein & McDaniel, 1990, 1996; see also Crawford et al., 2003). This should be explored with laboratory work to determine whether difficulties are the result of problems with phonologically encoding the instructions feeding into the retrospective component of PM and, potentially, therefore, the phonological deficit hypothesis (e.g., Vellutino et al., 2004) or with remembering to perform the intention (the prospective or planning component of PM). It is standard procedure to check that the participants remember what they were instructed to do at

the end of a PM task (e.g., Einstein et al., 2005) or test battery (e.g., Raskin, Buckheit & Sherrod, 2010) and so doing allows the researcher to check that the intention has been encoded successfully. Problems with the reliable access of information in retrospective memory may, thus, underpin the self-reported difficulties experienced by adults with dyslexia in both RM and PM. If this were to be the case, then the current results may highlight the lack of divergent validity in the PRMQ argued by Uttl and Kibreab (2011).

Given its involvement in PM (Einstein et al., 2000; Einstein et al., 1997; Marsh & Hicks, 1998; Smith et al., 2011; Ward et al., 2005), an alternative explanation may lie in working memory (e.g., Baddeley, 1986), especially since working memory deficits are a defining characteristic of dyslexia (e.g., Booth et al., 2010; McLoughlin et al., 1994). However, an explanation of the present findings solely in terms of dyslexia-related working memory deficits seems unlikely given the current evidence in the area. Smith-Spark et al. (2016) found that manipulating working memory load using time-based PM did not interact with participant group. Instead, their participants with dyslexia showed reduced accuracy of PM regardless of the demands placed on working memory by the ongoing tasks.

In conclusion, the data from the PRMQ (Smith et al., 2000) and proxy-PRMQ (Crawford et al., 2006) suggest that RM and PM problems are experienced more frequently in everyday life by adults with dyslexia relative to adults without dyslexia. The results support Khan's (2014) findings with children, indicating that problems in these memory systems are also perceived as being more frequent in adulthood by people with dyslexia. Indeed, stronger group differences were manifested when the questionnaire was applied to the range of ages for which it was designed. Furthermore, the findings suggest that the PM problems reported under laboratory conditions in adults with dyslexia (Smith-Spark et al., 2016) play out in an increased propensity

to error in day-to-day life, indicating difficulties under both Stanovich's (2009) algorithmic and reflective levels of cognition. The RM results are also consistent with objective reports of poorer long-term memory in dyslexia (Huestegge et al., 2014; McNamara & Wong, 2003; Menghini et al., 2010; Nelson & Warrington, 1980). Given the paucity of literature on the RM of adults, further laboratory or naturalistic work is recommended to explore these difficulties in more depth. This recommendation applies also to PM. The use of such measures could prove instructive in identifying whether there are areas of RM and PM which are less affected by dyslexia and, if possible, harnessing these to improve memory performance and, thus, quality of adult life.

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Table 1

*Group mean background characteristics. Standard deviations are shown in parentheses.*

| *Scale* | Group with dyslexia | Group without dyslexia | *Independent-samples t-test* | | | |
|---|---|---|---|---|---|---|
| | | | *t* | *df* | *p* | *d* |
| Age (years) | 23.82 (4.14) | 23.31 (4.63) | < 1 | 52 | .669 | - |
| WAIS-IV Short-form IQ | 107.32 (7.63) | 107.34 (9.47) | < 1 | 52 | .993 | - |
| DAST non-word reading score | 77.21 (11.48) | 92.35 (3.25) | 6.69 | 31.60* | < .001 | 1.33 |
| WORD spelling test raw score | 40.21 (3.76) | 44.77 (1.73) | 5.77 | 38.44* | < .001 | 1.22 |
| Number of participants with WORD spelling ages of ≤ 17 years | 19 | 0 | | - | - | - |

* Levene's test was significant so equal variance were not assumed.

Table 2

*Group mean scores (SDs in parentheses) and Independent-samples t-tests results for the total PRMQ, Prospective scale, and Retrospective scale measures for the PRMQ respondents.*

| *Scale* | Group with dyslexia | Group without dyslexia | *Independent-samples t-test* | | | |
|---|---|---|---|---|---|---|
| | | | *t* | *df* | *p* | *d* |
| Total PRMQ score | 51.11 (11.60) | 37.77 (8.32) | 4.82 | 52 | < .001* | 1.10 |
| Prospective score | 27.14 (6.60) | 20.00 (4.57) | 4.59 | 52 | < .001* | 1.06 |
| Retrospective score | 23.96 (5.52) | 17.77 (4.45) | 4.52 | 52 | < .001* | 1.05 |

* Significant at a Bonferroni-corrected α-level of .017.

Table 3

*Group means (SDs) and univariate F-test results for the PRMQ scale raw scores of the PRMQ respondents. Higher scores indicate a greater self-reported propensity to memory problems.*

| PRMQ scale | Mean raw scores (*SD*) | | MANOVA test statistics | | | |
|---|---|---|---|---|---|---|
| | Group with dyslexia | Group without dyslexia | *F* (1, 52) | *MSE* | *p* | $\eta_p^2$ |
| Prospective short-term self-cued | 3.57 (0.88) | 2.85 (0.75) | 10.61 | 0.668 | .002 | .170 * |
| Prospective short-term environmentally-cued | 3.52 (1.00) | 2.54 (0.71) | 16.94 | 0.764 | .001 | .246 * |
| Prospective long-term self-cued | 3.34 (0.95) | 2.31 (0.74) | 19.60 | 0.732 | < .001 | .274 * |
| Prospective long-term environmentally-cued | 3.14 (1.03) | 2.31 (0.57) | 13.41 | 0.701 | .001 | .205 * |
| Retrospective short-term self-cued | 3.66 (0.85) | 2.73 (0.79) | 17.25 | 0.676 | < .001 | .249 * |
| Retrospective short-term environmentally-cued | 2.50 (0.90) | 1.73 (0.47) | 15.02 | 0.531 | < .001 | .224 * |
| Retrospective long-term self-cued | 3.07 (0.98) | 2.15 (0.75) | 14.85 | 0.764 | < .001 | .222 * |
| Retrospective long-term | 2.75 (0.80) | 2.27 (0.72) | 5.34 | 0.584 | .025 | .093 |

environmentally-cued

Significant at a Bonferroni-corrected α-level of .006.

Table 4

*Mean estimated true scores for each participant group by questionnaire type and memory type.*

| Questionnaire type | Memory type | Participant group | Mean (SD) |
|---|---|---|---|
| PRMQ | Retrospective | Group with dyslexia | 40.62 (8.65) |
| | | Group without dyslexia | 51.29 (7.35) |
| | | Total | 45.74 (9.63) |
| PRMQ | Prospective | Group with dyslexia | 39.12 (11.64) |
| | | Group without dyslexia | 50.46 (7.59) |
| | | Total | 44.56 (11.36) |
| Proxy-rating PRMQ | Retrospective | Group with dyslexia | 39.50 (9.63) |
| | | Group without dyslexia | 48.33 (5.76) |
| | | Total | 43.74 (9.10) |
| Proxy-rating PRMQ | Prospective | Group with dyslexia | 47.85 (9.62) |
| | | Group without dyslexia | 54.00 (6.27) |
| | | Total | 50.80 (8.68) |