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Time-based prospective memory in adults with developmental dyslexia

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ABSTRACT

Prospective memory (PM) is memory for delayed intentions. Despite its importance to everyday life, the few studies on PM function in adults with dyslexia which exist have relied on self-report measures. To determine whether self-reported PM deficits can be measured objectively, laboratory-based PM tasks were administered to 24 adults with dyslexia and 25 age- and IQ-matched adults without dyslexia. Self-report data indicated that people with dyslexia felt that time-based PM (TBPM; requiring responses at certain times in the future) was most problematic for them and so this form of PM was the focus of investigation. Whilst performing the ongoing task from which they were required to break out every 3 min to make a PM-related response, the participants were allowed to make clock checks whenever they wished. The cognitive demands made on ongoing behaviour were manipulated to determine whether loading executive resources had a mediating role in dyslexia-related deficits in PM, resulting in three tasks with varying working memory load. A semi-naturalistic TBPM task was also administered, in which the participants were asked to remind the experimenter to save a data file 40 min after being given this instruction. Dyslexia-related differences were found across all three computerized tasks, regardless of cognitive load. The adults with dyslexia made fewer correct PM responses and also fewer clock checks. On the semi-naturalistic task, the participants with dyslexia were less likely to remember to remind the experimenter to save the file. This is the first study to document PM deficits in dyslexia using objective measures of performance. Since TBPM impairments were found under more naturalistic conditions as well as on computerized tasks, the results have implications for workplace support for adults with dyslexia.

1. Introduction

Developmental dyslexia (henceforth, dyslexia) is the most commonly reported of the developmental disorders (e.g., Lyon, 1996; Shaywitz, 1998; Shaywitz & Shaywitz, 2003). Estimates place its prevalence in the population of the Western world at 5–17.5% (e.g., Badian, 1984; Katusic, Colligan, Barbaresi, Schaid, & Jacobsen, 2001; Lyon, 1996; Pennington et al., 1991; Shaywitz, 1998; Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). Dyslexia is characterized by specific difficulties with decoding the written word, with these problems occurring despite adequate educational opportunities, intelligence, and socioeconomic status (e.g., World Federation of Neurology, 1968; Orton Dyslexia Society Research Committee, 1994).

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However, as well as reading and spelling problems, impairments with memory have also been documented in children and adults with dyslexia. Difficulties with short-term and working memory have featured chiefly amongst these (e.g., Booth, Boyle, & Kelly, 2010; Jorm, 1983; Palmer, 2000). One largely neglected area of memory with particular importance to everyday functioning is prospective memory (PM), also known as memory for delayed intentions (Winograd, 1988) or remembering to remember (Mäntylä, 1994). Despite its impact on daily life (e.g., McDaniel & Einstein, 2007), little research has been carried out on PM in dyslexia apart from a small amount of self-report evidence to suggest that PM is more frequently impaired (Khan, 2014; Smith-Spark, Zięcik, & Sterling, submitted, in preparation). Despite these indications of a PM deficit in dyslexia, self-reports of an increased susceptibility to PM failure have yet to be corroborated by objective measures of performance. The present study was, therefore, conducted in order to determine whether subjective reports of more frequent PM failures actually play out in poorer PM performance under laboratory-based conditions.

The function of two key memory components is required for PM to be successful, namely a prospective component and a retrospective component. The prospective component allows the intention to be recalled at the appropriate point in the future, whilst the retrospective component permits the nature of the intention itself to be remembered. Prospective memory can be divided into two main types. Event-based PM (EBPM) requires an individual to remember to perform an intention in response to a cue in the environment; for example, remembering to post a letter as intended when seeing a post box. Conversely, time-based PM (TBPM) requires an individual to remember to perform an intention at a particular time in the future, in the absence of salient environmental cues to guide performance; for example, remembering the intention to call a friend 30 min from now. In the absence of external props to aid memory, TBPM is argued to require much more in the way of self-initiated mental processes (e.g., Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995), with the individual having to rely on, for example, free recall to remember to make appropriate checks of the time.

This reliance on self-initiated processes has led to arguments that executive functioning is more closely related to TBPM than EBPM (Martin, Kliegel, & McDaniel, 2003; McDaniel & Einstein, 2000; although see Gonneaud et al., 2011, for a contrary view). Executive functioning relates to higher-order cognitive processes such as inhibiting habitual responses, shifting between cognitive sets, updating the contents of working memory, and accessing information held in long-term memory in a controlled, strategic manner (e.g., Fisk & Sharp, 2004; Miyake & Friedman, 2012; Miyake et al., 2000). Martin et al. (2003) have proposed that executive functioning is engaged during intention formation and intention execution but plays less of a role in retaining intentions over the intervening period between formation and execution. Van den Berg, Aarts, Midden, and Verplanken (2004) argue that executive functions are called upon to enable the individual to break out from ongoing task activity to perform a PM task.

As previously stated, there is a small body of evidence to suggest that people with dyslexia experience greater problems with PM than those without dyslexia. Smith-Spark (2000) employed a diary study methodology in which age- an IQ-matched adults were asked to record their everyday cognitive failures and slips of action (Cohen, 1996; Norman, 1981). Employing Reason's (1979) methodology, he instructed participants to keep a diary of any slips of action that they made in their day-to-day lives over a two-week period, instructing them to note down the nature of the slip and the circumstances prevailing at the time of its occurrence (e.g., that the participant was feeling tired or was in a hurry). Whilst Smith-Spark's interest was predominantly in the types of error that occurred when habitual actions went awry, many of the errors which were recorded by the participants fell outside Reason's taxonomy of slips of action. Smith-Spark, therefore, adopted a broader categorization of everyday cognitive error alongside Reason's taxonomy. One of these categories was forgetfulness. These recorded acts of forgetfulness were often retrospective (or episodic) in nature (e.g., forgetting where possessions had been left or failing to remember previous actions), but many of these errors were prospective in nature (for example, forgetting to return library books as intended or taking off a wristwatch and then forgetting to put it back on again afterwards as intended). Smith-Spark found that the participants with dyslexia reported a greater propensity to forgetfulness in their day-to-day lives.

Further to this, Smith-Spark, Fawcett, Nicolson, and Fisk (2004) raised the possibility of impaired PM in adults with dyslexia when considering group differences on the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982). The participants with dyslexia rated themselves as being significantly more prone to failures in everyday cognition than age- and IQ-matched controls on two CFQ items which could be construed as drawing on PM (c.f., Maylor, 1993).

Khan (2014), however, was the first to specifically investigate PM in dyslexia. He administered the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, & Maylor, 2000) to children across Classes 5 to 12, with a mean age of 12 years. He found that the children with dyslexia rated themselves as being significantly more susceptible to PM failures than children without dyslexia, especially when self-cued performance was required. Whilst this work was an important first step in documenting PM problems in dyslexia and indicating where exactly problems might lie, it should be noted that there are a number of methodological concerns related to this paper. Firstly, no background literacy measures were reported for either group. It is important to check the validity of the participant groupings and not simply rely on the reports of schools. Secondly, no data relating to IQ or other cognitive measures were presented (despite mention of IQ and a cognitive test battery in the Method) to allow a comparison of the relative ability levels across the participant groups, again potentially hindering interpretation of the results if there were to be group differences on these measures. Thirdly, the range of ages of the 115 children taking part in the study was large, spanning seven school years. The opportunities for a child to exercise his or her own PM independently of his or her parents will vary considerably with age, with older children having greater responsibility for their actions than younger children and, usually, having a more personally (rather than parentally)