Everyday memory in adults with dyslexia

James H. Smith-Spark

London South Bank University, United Kingdom

Author Contact

Dr Jamie Smith-Spark, Senior Lecturer, Division of Psychology, School of Applied Sciences, London South Bank University, 103 Borough Road, London, SE1 0AA, United Kingdom.

Email smithspj@lsbu.ac.uk

Telephone +44 (0)20 7815 5884

Fax +44 (0)20 7815 8099

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People do not "grow out" of dyslexia when they become an adult and its effects are still experienced (e.g., McLoughlin, Fitzgibbon & Young, 1994). As well as affecting skills related to those used in reading and writing, dyslexia also leads to broader problems in other areas of cognition (e.g., Nicolson & Fawcett, 1990, 2008). To ensure the continuing support of people with dyslexia into adulthood, we need to understand whether difficulties usually reported under laboratory conditions actually have an impact on the everyday lives of adults with dyslexia. Since starting my PhD at the University of Sheffield over 20 years ago under the supervision of Prof John Fisk, Prof Rod Nicolson, and Prof Angela Fawcett, I have studied the cognition of adults with dyslexia in both the laboratory and in everyday situations. My research has taken in various facets of cognition in adults with dyslexia, namely short-term and working memory (Smith-Spark, Fisk, Fawcett & Nicolson, 2003; Smith-Spark & Fisk, 2007), cognitive failures (Smith-Spark, Fawcett, Nicolson & Fisk, 2004), long-term memory (Smith-Spark & Moore, 2009), prospective memory (Smith-Spark, Zięcik & Sterling, 2016a, b), and executive functioning (Smith-Spark, Henry et al., 2016). Difficulties with cognition can have tremendous implications for quality of life and opportunity for adults with dyslexia. If unrecognised or unsupported, these problems can have serious implications for life chances and the ability of the individual with dyslexia to achieve his or her full potential in higher education and/or employment. To ensure that the needs of adults with dyslexia are appropriately met (as required by legislation in some countries, e.g., the Equality Act, 2010, in the United Kingdom), problems need to be highlighted which may be outside the popular conception of what dyslexia entails. In this article, I will focus on how dyslexia can affect adults' cognition when carrying out everyday tasks unrelated to reading and writing. In the following sections, I will consider different aspects of cognition in everyday life and indicate how adults with dyslexia experience difficulties with them.

Cognitive failures

As part of my PhD, I became interested in the notion of everyday cognition and, in particular, the types of error which accompany the performance of day-to-day tasks. The nature of these errors can give us some insight into the cognitive processes underlying them, even if the results may not be as scientifically rigorous as those generated under strictly controlled laboratory conditions. The kinds of error that I am talking about are mistakes such as unwrapping a foodstuff and putting it in the rubbish bin whilst holding onto the wrapper or getting into the shower still wearing one's socks. The idea here is that there is a significant deviation from a usual sequence of actions that usually leaves us wondering how on earth we managed to mess up and feeling a little silly! Whilst the examples I have given here are light-hearted and have no serious consequences, cognitive failures can sometimes have serious repercussions for those caught up in them (e.g., deviations from railway or airline safety procedures).

Slips of action (Reason, 1979) is the term used to describe the kinds of mistake we sometimes find ourselves making on habitual tasks, ones that we are usually able to carry out effectively and without incident. These errors often occur when we are tired or distracted. Work by Torgeson (1977) and Levin (1990) suggested that children with dyslexia are worse at organising and planning. It seemed to me that these areas of weakness might still play out in the everyday cognition of adults with dyslexia. Therefore, I decided to investigate how frequent slips of action were in adults with dyslexia compared with adults without dyslexia.

I asked my participants to keep a two-week diary, writing down any mistakes that they made when carrying out tasks and routines. Fortunately for me, my participants interpreted the instructions more broadly than I had imagined and very diligently wrote down all manner of slips that they made over the two-week period. The adults with and without dyslexia did not differ in how often they committed slips of action as defined by Reason

(1979). However, the group with dyslexia reported more failures of memory, with these being approximately equally split between memory for things past (retrospective or episodic memory; such as telling a friend the same story twice without noticing the repetition or forgetting that a relative was out of the country when trying to contact them on their home telephone number) and for things future (prospective memory; such as forgetting to return library books, buy groceries or post letters despite the intention to do so). I will return to these interesting findings later in this article when considering different aspects of memory.

As well as the diary study, I also gathered self-report questionnaire data to compare perceptions of how frequently everyday errors occurred over a more extended period of time. The results of this study are reported in Smith-Spark et al. (2004). I asked my participants to complete the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald & Parkes, 1982). This questionnaire asks respondents to estimate how frequently a range of different types of error had occurred over the previous six months. The adults with dyslexia felt that they experienced such mistakes more frequently. In particular, they reported errors arising from distractibility, over-focusing on a task to the detriment of noticing things around them, and word-finding. I also asked my participants to get a housemate or close family member also to rate how often they felt mistakes were made by the participant. These close associates also rated the adults with dyslexia as making cognitive errors more frequently, thereby corroborating the self-reports. Obtaining similar ratings from others means that the self-reports cannot be explained away by negative self-perceptions arising from lowered self-esteem in childhood (e.g., McNulty, 2003; Riddick, Sterling, Farmer & Morgan, 1999). More recently, Leather, Hogh, Seiss, and Everatt (2011) have also used the Cognitive Failures Questionnaire. They too found cognitive failures being more frequently reported by adults with dyslexia.

Executive Functioning

In contrast to cognitive failures which are errors in our well-practised or habitual actions, responding successfully to novel situations or tasks calls upon another, more complex form of cognition (c.f., Norman & Shallice, 1986). Executive functioning is an umbrella term used to describe this range of complex, higher-order cognitive abilities which allow strategic behaviour. Executive functions include skills such as preventing a habitual response in favour of one that is new or less used but more relevant in the current situation, problem solving, planning, adapting our behaviour in response either to changes in the environment or what is required of us, moving flexibly between different cognitive processes or operations, staying on task in the face of distraction, and updating memory in the light of newly available information (e.g., Diamond, 2013; Fisk & Sharp, 2004; Miyake & Friedman, 2012).

Smith-Spark, Henry et al. (2016) administered a self-report questionnaire about executive problems in day-to-day life to adults with and without dyslexia. This questionnaire is called the Behavior Rating Inventory of Executive Function – Adult Version (Roth, Isquith & Gioia, 2005). Overall, the adults with dyslexia reported more everyday problems with executive functioning in the past month. The differences were focused on three of the nine areas (or scales) probed by the questionnaire. These scales were Working Memory, Plan/Organize, and Task Monitor. The Working Memory scale, as the name suggests, assesses how well individuals feel that they are able to maintain information temporarily in memory to allow responses to be made. Short-term and working memory deficits in dyslexia have been extensively explored in the laboratory (e.g., Jeffries & Everatt, 2004; Jorm, 1983; Menghini, Finzi, Carlesimo & Vicari, 2011; Palmer, 2000; Swanson & Sachse-Lee, 2001), including adults (e.g., Smith-Spark et al., 2003; Smith-Spark, Henry et al., 2016; Smith-Spark & Fisk, 2007). It would seem that these problems play out in everyday life across a range of situations away from the fairly artificial tasks presented in laboratory settings. Questions

making up the Plan/Organize scale reflected how well the individual oversees current and future task demands, anticipating future events, setting goals, and organize and understand the overall points of spoken or written presentations. The problems self-reported by the adults with dyslexia in this area sit well with the arguments of Torgeson (1977) and Levin (1990) regarding organisational and planning difficulties in dyslexia. Task Monitor reflects questions relating to how well individuals can keep track of their own performance and keep an eye on how their behaviour affects people around them.

Long-term memory

As well as affecting adult's memory when maintenance, processing, and recall of information is short-term and temporary (e.g., Smith-Spark et al., 2003; Smith-Spark & Fisk, 2007), dyslexia may also affect the ability to lay down memories to be accessed minutes, days, weeks, or even years later. Since the literature is very small, I will cover evidence from children as an indicator of likely differences in adulthood. An important distinction to make with long-term memory is between the recall of facts about the world (known as declarative memory) and one's subjective, personally experienced memories of past events (referred to as episodic or autobiographical memory). To illustrate the point, I am currently exercising my declarative memory in recalling the various concepts and studies that I want to write about. However, I also find myself to an extent mentally reliving specific events in my life around the time that I was running a particular experiment. Indeed, I am aware of the demands on my executive functions in remaining "on task" with writing this article in the face of these distractions! These conflicting calls on my cognitive resources give an example of the way in which these different aspects of cognition are very much intertwined but tend to be separated so that research can answer manageable questions.

Returning to the point of this section, a few studies have found difficulties in long-term memory between individuals with dyslexia and those without. McNamara and Wong

(2003) asked children to report the procedure involved in borrowing a library book. They found poorer memory for the sequence of steps in their participants with dyslexia. Nelson and Warrington (1980) found that children with dyslexia were poorer at recognising that words presented to them were the same ones that they had been shown a little earlier. Menghini, Carlesimo, Marotta, Finzi, and Vicari (2010) found poorer recall of lists of verbal and visuospatial items when tested immediately after the lists had been presented. Huestegge, Rohrβen, van Emingen-Marbach, Pape-Neumann, and Heim (2014) found children with dyslexia had poorer memory for the details of abstract shapes presented 45-60 minutes earlier, although their overall accuracy was similar to children without dyslexia.

Long-term memory difficulties in dyslexia may not be limited to storing impersonal or factual information to be accessed at a later date. Instead, they may also affect the way in which distinct personally experienced episodes from an individual's past are recalled. There is currently only a very small literature in this area but difficulties with episodic memory have been reported. McNamara and Wong (2003) asked children to recall details of a dance that they had watched five weeks earlier, finding poorer recall of details in a group of children with learning disabilities, some of whom had dyslexia. At a recent conference, Jucla et al. (2016) gave a poster presentation showing that children with dyslexia recalled less autobiographical information, both spontaneously and when cued by a researcher. I am looking forward to reading more fully about this work when it is published.

Self-report questionnaire data from schoolchildren have also suggested that individuals with dyslexia experience more frequent problems in remembering the detail of distinct episodes over both the short- and longer-term (Khan, 2014). Smith-Spark et al. (2016) used the same questionnaire but administered it to adults. Adults with dyslexia felt that they experienced more problems across the board. As well as testing retrospective memory, this questionnaire also assesses prospective memory (indeed, it is called the

Prospective and Retrospective Memory Questionnaire; Smith, Della Sala, Logie & Maylor, 2000). I will return to these findings later.

My diary study (Smith-Spark, 2000) also picked up on a larger number of retrospective memory errors made by adults with dyslexia. These included mistakes such as forgetting previous actions (for example, where they had put down books or keys), problems with remembering details of events (either recent or more distant in the past), and forgetting names of people, films, and books. Smith-Spark and Moore (2009) argued for differences in the way that information is stored and/or retrieved in dyslexia, finding that adults with dyslexia responded differently to material that they had first learnt when young and that which they had encountered for the first time more recently. As far as I am aware, these latter studies are the only evidence of weaker long-term memory abilities in adults with dyslexia.

Prospective memory

Prospective memory is about "remembering to remember" (Mäntylä, 1994) and is a very important aspect of day-to-day life (e.g., McDaniel & Einstein, 2007). Where there is a delay (even of a few seconds) between forming an intention to do something and the opportunity arising to carry it out, prospective memory is called upon. Prospective memory allows people to complete all kinds of everyday tasks successfully, such as attending appointments, paying bills on time, meeting friends, buying items of grocery on the way home from work, returning telephone calls, remembering to send birthday cards, and taking regular medication. Before discussing my studies on prospective memory in adults in dyslexia, I will take some time to explain prospective memory in general, given that it is an emerging area of the cognitive psychological literature and may be unfamiliar to readers.

Prospective memory tasks can be either habitual (e.g., taking regular daily medication or paying one's monthly credit card bill) or more novel or one-off in nature. Whatever the exact prospective memory task might be, there are two aspects to prospective remembering

(e.g., Einstein & McDaniel, 1996). Firstly, there is a prospective or planning component concerned with ensuring that the intention is remembered at the appropriate point in the future. Secondly, a retrospective component is responsible for remembering exactly what needed to be done when the intention itself is remembered. We have all experienced times when we have experienced these two components not working successfully in concert. For example, we notice the prospective component working when we remember that we need to do something but cannot remember what that "something" actually was. Similarly, the retrospective memory component comes to the fore when we experience the sinking feeling of remembering the details of a task that we meant to perform after the opportunity actually to do it has passed!

The nature of a prospective memory task can also be classified as either event-based or time-based. An event-based prospective memory task is one where something in the surrounding environment reminds us of the intention to act; for example, seeing a post box serves as a reminder to post the letter in one's bag. On the other hand, a time-based prospective memory task is one where an intention has to be acted upon at a specific point in time; for example, returning a telephone call in 30 minutes' time.

Unlike event-based prospective memory, there are no obvious external cues to remind us to perform a time-based task. As a consequence, this type of prospective memory involves more internally-driven strategies to remember to act out the intention at the appropriate point in the future. These strategies include remembering to check a clock regularly in the intervening period or mentally rehearsing the intention every so often in the interim. The need for more strategic behaviour means that executive functions are called upon more greatly when carrying out time-based prospective memory tasks than event-based ones (Martin, Kliegel & McDaniel, 2003; McDaniel & Einstein, 2000; although Huang, Loft & Humphreys, 2014, argue against this). Adults who have better executive functions have been

found to be better at prospective memory (e.g., Bisiacchi, Schiff, Ciccola & Kliegel, 2009; Gonneaud et al., 2011).

Prospective memory has only recently come under the spotlight of dyslexia researchers. My diary study (Smith-Spark, 2000) identified prospective memory problems as being one type of difficulty that adults with dyslexia experienced with their everyday memory, but this was rather tangential to the focus of my PhD and, consequently, was mentioned very much in passing and not fully explored. I did, however, make a mental note to return to what seemed a fascinating area of research!

This return took some 10 years and an undergraduate psychology student, Adam Zięcik, expressing an interest in doing a PhD with me on adult cognition in dyslexia. Having kept abreast of the literature in the intervening period, I proposed the idea of studying prospective memory and he was very taken with it. Adam successfully completed his part-time PhD in 2015, co-supervised by Dr Chris Sterling. We are in the process of seeing the research published across several journals. It certainly proved to be a very interesting and fruitful subject for PhD work!

At present, there is only a small literature on prospective memory in dyslexia but it has highlighted difficulties in children (Khan, 2014) and adults (Smith-Spark, Zięcik & Sterling, 2016a, b). Certain aspects of prospective memory seem to be more affected than others. I will now describe this evidence. Currently, there is more literature on adults with dyslexia than there is on children with the condition, something of an oddity for dyslexia research! However, as I will argue later, its potential impact is greater on adults who have to rely on their own memory to get things done rather than being reminded about tasks as children often are.

We (Smith-Spark, Zięcik et al., 2016b) were the first to report prospective memory problems in dyslexia under laboratory conditions. We explored time-based prospective

memory using both a computerised task and a semi-naturalistic task. Since there are usually intervening activities in real-life between forming an intention and carrying it out, their computerised task involved an ongoing task to keep the participants busy in the meantime. Each trial of the ongoing task presented the participants with the faces of six famous people. The participants had to decide whether more of the celebrities so displayed were living or dead by making a button press. This, then, was the ongoing task from which they needed to break out to perform the prospective memory task every three minutes. This task required them to remember to press a particular key on a keyboard to make a prospective memory response. To help the participants respond at the correct time, they were allowed to check a clock positioned behind them as often as they liked during the task, with these clock checks being recorded. We found that the adults with dyslexia were less accurate at the prospective memory task, remembering to press the key on the keyboard fewer times the adults without dyslexia. They also made fewer checks of the clock whilst doing the ongoing task. Alongside the computerised tasks, we also presented a semi-naturalistic time-based task. This required the participants to remind the experimenter to save a file 40 minutes later. Again, the adults with dyslexia were less likely to remember to remind the experimenter than the adults without dyslexia.

Are the prospective memory difficulties found on laboratory-based tasks reflected in everyday life? The semi-naturalistic task that we presented (Smith-Spark, Zięcik et al., 2016b) provided something of a bridge between cognition in the laboratory and the outside world. It certainly suggested that prospective memory might be worse in the day-to-day lives of adults with dyslexia. However, this was one specific task. The question remained as to whether greater prospective memory difficulties were present more generally, over a large number of very diverse tasks over a timespan of weeks or months. Because of this extended timespan, we needed to call upon the self-perceptions of adults with and without dyslexia.

Self-report measures on typical, everyday performance allow us to understand self-perceptions of usual levels of performance rather than optimal performance on an individual task in the laboratory where the pressure may be felt to be on to do as well as possible (c.f., Stanovich, 2009).

Self-report questionnaire evidence indicates that prospective memory difficulties do indeed seem to be more frequent over longer time-frames and across a range of different types of task, in both children (Khan, 2014) and adults (Smith-Spark, Zięcik et al., 2016a). We found that the self-perceptions of the adults with dyslexia were supported by close associates of the participants who were asked to rate the memory abilities of the respondents using exactly the same set of questions. As with the Cognitive Failures Questionnaire-for-others used by Smith-Spark et al. (2004), collecting proxy-ratings is important in ensuring that any problems reported by people with dyslexia are simply not related to a negative self-image (e.g., McNulty, 2003; Riddick, Sterling, Farmer & Morgan, 1999). If similar views are obtained from both participants and those in close contact with them, it suggests that these views are likely to reflect the real state of affairs. The ratings from close associates of the participants, therefore, corroborated the self-reports of the adults with dyslexia in indicating that they experienced more frequent difficulties with prospective memory.

Putting the laboratory and everyday results together, we can see that prospective memory seems to be poorer in dyslexia. But why do people with dyslexia experience these problems more than individuals without dyslexia? Three different explanations suggest themselves to me.

Firstly, problems in the encoding or access of phonological information in long-term memory may be responsible for the increased prospective memory lapses in dyslexia. These difficulties might be due to a failure to store the intention in memory efficiently in the first place. Alternatively, they may arise from failing to access the information about what it is

that is meant to be done at the point at which it is required. This explanation suggests that problems lie in the retrospective component of prospective memory discussed previously. The role of the retrospective component in prospective memory needs to be explored in greater depth in future research.

A second explanation lies in the time perception difficulties experienced by people with dyslexia (e.g., Bruno & Maguire, 1993; Klein, 2002; Nicolson, Fawcett & Dean, 1995). This could explain why problems show themselves more on time-based tasks rather than event-based ones. There is only a small amount of research on time perception as a predictor of prospective memory performance (e.g., Mackinlay, Kliegel & Mäntylä, 2009; McFarland & Glisky, 2009). Furthermore, none of this work has used durations which map on to the extended periods of time that usually accompany prospective memory (being instead concerned with durations in the range of milliseconds rather than minutes, hours or days). From the few studies in this area, it would seem that time perception is more strongly related to clock-checking behaviour when performing the task rather than the accuracy of prospective memory itself (Labelle, Graf, Grondin & Gagné-Roy, 2009; Mioni & Stablum, 2014). As mentioned previously, Smith-Spark, Zięcik et al. (2016b) found that adults with dyslexia made fewer clock checks on their computerised time-based prospective memory task, so there may well be a link here.

The third line of explanation lies in the prospective component of prospective memory. As I have already mentioned, stronger executive functions are associated with better prospective memory (e.g., Bisiacchi et al., 2009; Gonneaud et al., 2011). We know that executive functions tend to be worse in adults with dyslexia (e.g., Brosnan et al., 2002; Smith-Spark, Henry et al., 2016), so it is easy to see how, in general, these executive functioning problems might have a negative impact on prospective memory. More particularly, executive functions are needed to break out from ongoing activity to perform a

prospective memory task (e.g., Cockburn, 1995; Van den Berg, Aarts, Midden, & Verplanken, 2004). Weaker executive functions in dyslexia should, therefore, mean that fewer successful prospective memory responses are made in dyslexia. However, the ongoing activity (from which they are less likely to break out!) should be performed at a roughly equivalent level to that of people without dyslexia. This is the pattern which is emerging from the research I have described in this article. This explanation would also seem to tally with the results of the Cognitive Failures Questionnaire paper (Smith-Spark et al., 2004) on which the participants with dyslexia reported being over-focused and not noticing or responding to other events around them. These difficulties in moving from one focus of attention to another may result in poorer prospective memory.

This third explanation seems to me to be the best candidate to explain prospective memory problems in dyslexia. Of course, it could also be a combination of all three explanations that lead to more frequent prospective memory problems! Further research is needed to determine which of these explanations is correct.

Conclusions

This article has highlighted a number of different ways in which the day-to-day cognition of adults can be affected by dyslexia. The difficulties that I have described in this chapter cannot be explained by differences in age or IQ between my participant groups as, in all cases, these were matched whilst reading and spelling measures indicated clear differences between the two groups. The research which I have reviewed serves as a useful reminder that individuals do not leave their dyslexia behind when reaching adulthood (McLoughlin et al., 1994). Instead, they will continue to experience dyslexia-related difficulties which are likely to have a negative impact when going about their daily tasks, even when those tasks do not require reading and writing skills.

It is important to document areas of difficulty to ensure that adults with dyslexia continue to be supported into adulthood to give them the best possible life chances. In the usual way of things, an individual will spend more of their life in adulthood than in childhood, so whilst the effects of dyslexia may be more greatly felt in childhood, they have to be lived with for longer in adulthood. Moreover, the demands made on memory in adulthood are likely to be very different from those made on the memory of a child (c.f., McLoughlin et al., 1994), as are the consequences of it going wrong.

Attention has, quite rightly, been focused on dyslexia and childhood, with research helping to inform early diagnosis and intervention. Identifying problems early in life and providing support to improve them is very much the best approach, especially given the greater flexibility of the younger brain. However, one of the aims of such interventions should be to prepare children with dyslexia for the broader cognitive demands of adulthood, identifying methods of helping them that can be carried through life across a range of experiences. In childhood, parents, carers, and teachers act as a kind of "external memory" (c.f., Clark & Chalmers, 1998; Spurrett & Cowley, 2010) in support of the child's everyday cognition, ensuring that particular tasks are performed or reminding the child to carry them out. Adults are not so fortunate in this regard. The onus is very placed on them to remember to carry out necessary tasks effectively at the time that they need to be done. Unfortunately, despite knowing an adult has dyslexia, people are likely to be much less forgiving of their errors than they would be of a child with dyslexia!

All of this means that it is important to study the memory of adults in its own right (c.f., McLoughlin et al., 1994), to identify where problems lie and, in the longer-term, devise ways to overcome them. The problems of adults with dyslexia are most definitely not confined to literacy and laboratory-based cognitive tasks. Instead, they have a broader impact on everyday life and this needs to be accounted for when providing support. As the present

article has shown, the everyday perceptions and experiences of adults with dyslexia are useful in highlighting where these concerns lie.

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Author note

James H. Smith-Spark, Division of Psychology, School of Applied Sciences, London South Bank University, United Kingdom.

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