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Autobiographical memory in Parkinson's disease: A retrieval deficit
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Abstract

This study examined the effects of providing cues to facilitate autobiographical memory retrieval in Parkinson's disease. Previous findings have shown that individuals with Parkinson's disease retrieve fewer specific autobiographical memories than older adult controls. These findings are clinically significant since the quality of autobiographical memory is linked to identity and sense of self. In the current study, 16 older adults with Parkinson's disease without dementia and 16 matched older adult controls were given 3 min in which to recall autobiographical memories associated with five different time periods and to give each memory a short title. Participants were later asked to retrieve the memories in three phases: firstly in a free recall phase; secondly in response to general cues (time periods) and finally in response to specific cues (the short titles previously given). The number of memories and the quality of the memory (general or specific) was recorded in each condition. Compared with matched older adult controls, the Parkinson's disease group was impaired in retrieving the memories that they had previously given in the free recall phase and in response to general cues. The performance of the group with Parkinson's disease was only equivalent to the older adults when they retrieved memories in response to self-generated cues. The findings are discussed in relation to theories of autobiographical memory and the neuropsychology of Parkinson's disease.

1. Introduction

Parkinson's disease (PD) is a neurodegenerative disorder characterized by motor symptoms, caused by a loss of dopaminergic neurons in the basal ganglia. Besides motor symptoms, cognitive deficits are often reported in PD; due to extensive connections between the basal ganglia and the pre-frontal cortex (Lewis, Dove, Robbins, Barker, & Owen, 2003). Amongst the cognitive difficulties reported in PD several studies are indicative of memory deficits. For example, episodic memory deficits have often been reported particularly on free recall tasks (Gabrieli, Singh, Stebbins, & Goetz, 1996; Johnson, Pollard, Vernon, Tomes, & Jog, 2005; Whittington, Podd, & Stewart-Williams, 2006; see Dujardin & Laurent, 2003 for a review). A less well-explored area in Parkinson's disease is autobiographical memory (AM). This study is a follow-up of our previous experiment revealing specific AM deficits in PD (Smith, Souchay, & Conway, 2010). The novelty of this study was to explore ways to improve AM retrieval in PD. First explorations of autobiographical memory have distinguished between episodic autobiographical memory, which involves remembering personally experienced past events and personal semantic memory, which consists of knowledge and recollection of facts from one's past (Tulving, Schacter, McLachlan, & Moscovitch, 1988). Recent models (Conway & Pleydell-Pearce, 2000; Conway, 2005) emphasize the role of the self as an organizing structure. For example, according to the Self-Memory System (SMS; Conway, 2005), autobiographical memory (AM) contains different types of representations organized in a hierarchical structure, which range from conceptual knowledge to event-specific knowledge. Conceptual knowledge refers to lifetime periods (e.g., being a student at university) whilst event-specific knowledge refers to sensory-perceptual episodic memories (e.g., submitting your first lab report).

The neuropathological findings in PD support the prediction that retrieval of personal events might be impaired in this clinical population. Most reviews in the literature on Parkinson's disease have focused on the dysfunction of prefrontal cortex as a predominant marker of the disease (e.g., Taylor, Saint-Cyr, & Lang, 1990; Prull, Gabrieli, & Bunge, 2000; Dujardin & Laurent, 2003; Owen, 2004). In fact, individuals with PD have often been described as presenting a 'frontal-like' cognitive degeneration with impairments on executive tasks (Lewis et al., 2003; Zgaljardic, Borod, Foldi, & Mattis, 2003) and also memory processes supporting retrieval (Dubois & Pillon, 1997). In direct contrast with the extensive literature reviewing frontal lobe functioning in PD, recent evidence from neuroimaging studies suggest that PD is also characterized by a decline in the medial temporal lobe (MTL). Volumetric MRI studies in PD have documented atrophy of the hippocampus in PD, even in patients free of dementia (Barak et al., 2003; Bruck, Kurki, Kaasinen, Vahlberg, & Rinne, 2004; Tam, Burton, McKeith, Burn, & O'Brien, 2005).

Furthermore, many studies have showed that medial temporal lobe atrophy, and in particular atrophy in the hippocampus, significantly correlates with memory function (Bruck et al., 2004; Dujardin & Laurent, 2003; Ibarretxe-Bilbao, Tolosa, Junque, & Marti, 2009); Tam et al., 2005. However, both the frontal lobes and the medio-temporal lobes are critical brain regions for AM retrieval. Indeed, many neuroimaging studies have now highlighted the involvement of a distributed brain network (reviewed by Cabeza & St Jacques, 2007) during memory retrieval, including the medial and lateral prefrontal

cortex (PFC), lateral and medial temporal lobes (MTL, hippocampus, parahippocampus), ventral parietal cortex and posterior cingulate cortex (Cabeza & St Jacques, 2007).

Studies assessing autobiographical memory in Parkinson's disease are scarce. In fact, to the best of our knowledge, only two studies have been published on this topic (Sagar, Cohen, Sullivan, Corkin, & Growdon, 1988; Smith et al., 2010). In their inaugural study, Sagar et al. (1988) measured memory for personal events in PD using a modified version of the paradigm proposed by Crovitz and Schiffman (1974). Parkinson's patients with and without dementia were presented with ten cues such as bird, car, boy and were asked to generate personally experienced events from any lifetime period. Results showed that the PD group recalled fewer memories than control participants and also suggested that recall of personally experienced events in PD was characterized by overgenerality. Overgenerality of autobiographical memory (Williams & Broadbent, 1986) is defined as the tendency to recall repeated events or events lasting more than one day rather than specific events. The findings from Sagar et al. (1988) showed that PD patients were less likely to recall time-specific events and prone to generalize across similar episodes. In a more recent experiment, we explored whether or not autobiographical memory in PD was indeed characterized by overgenerality, in other words a lack of specificity (Smith et al., 2010).

The novelty of this study was to assess autobiographical memory in PD by referring to recent AM models (Conway & Pleydell-Pearce, 2000) and to measure two forms of AMs: personal facts and personal events. To do so, a modified version of the autobiographical fluency task proposed by Dritschel, Williams, Baddeley, and Nimmo-Smith (1992) was used. Participants were presented with five different lifetime periods (0-18 years, 19-30 years, 31-last 5 years, last 5 years, last 12 months; Piolino, Belliard, Desgranges, Perron, & Eustache, 2003) and were given 2 min to generate personal events and then another 2 min to generate personal facts (names). Results showed that the PD group recalled fewer personal events, especially for the last two lifetime periods, but were able to recall as many names as controls. When asked to give personal events, participants were instructed to give short descriptions of specific memories lasting no longer than 1 day. To assess overgenerality, the personal events generated were then classified as either general (e.g., narrative lasting more than 24 hrs or events fused together) or specific.

Supporting Sagar's first findings, our results showed a lack of specificity in autobiographical memory in Parkinson's disease as participants recalled fewer specific memories. In line with Sagar et al. (1988) suggestion, we proposed that overgeneral memories in PD are due to a failure to retrieve the information. Many findings support to the idea that retrieval deficits could lead to fewer personal memories and in particular fewer personal specific memories being retrieved in Parkinson's disease. The idea of retrieval deficits in PD is not novel. Indeed, many neuropsychological explorations of episodic memory in PD have demonstrated that deficits arise when patients are given a free recall task, whilst memory performance is relatively spared in recognition and cued-recall tasks (Flowers, Pearce, & Pearce, 1984; Ivory, Knight, Longmore, & Caradoc-Davies, 1999; Lees & Smith, 1983; Taylor, Saint-Cyr, & Lang, 1986). A similar pattern of results was found in studies exploring remote memory for public events that is deficits

in the recall of public events in PD when a recall task was used as opposed to a recognition task (Sagar et al., 1988; Venneri et al., 1997). These findings lead Sagar et al. (1988) to suggest that the deficits in remote memory for public events in PD were attributable to a retrieval failure.

Models of AM distinguish between two forms of memory retrieval. Direct (Conway & Pleydell-Pearce, 2000) or associated (Moscovitch, 1992) retrieval arises from the presentation of a highly specific and personally relevant cue which activates autobiographical knowledge and initiates a memory into consciousness (e.g., the smell of baking reminding you of cooking with your grandmother in her kitchen in Dorset). Generative (Conway & Pleydell-Pearce, 2000) or strategic (Moscovitch, 1992) retrieval occurs when generic cues (such a holiday from childhood) are used to probe memory retrieval. If participants are required to retrieve a specific memory and only generic cues are provided, participants need to engage in a memory search to gain access the memory in question. They will engage in an iterative search process whereby cues will be used to access specific memory records. If the wrong information is returned the search will be elaborated (search-elaboration process). For example, thinking where I went to the seaside with my Grandmother when I was young I remember she lived in Lancashire and we once went on a day out. Through process of search elaboration I then retrieve event specific details such as what we did and with whom (e.g., going on a horse and carriage ride). Our previous study showed that in PD retrieval of personal events lacked specificity, and we proposed that overgenerality of AM in PD was due to a failure of generative retrieval processes. Indeed, according to Conway and Pleydell-Pearce (2000) a dysfunction of the generative retrieval process leads people to abort the search process and this impacts on the specificity of the memories retrieved.

Furthermore, we suggested that AM difficulties in PD might be due to a reduction in connectivity in the brain network involved in AM (Addis, Wong, & Schacter, 2007) and maybe specifically to a dysfunction of the left lateral PFC highly involved in generative retrieval (Conway et al., 1999). The question is thus how to increase retrieval of specific autobiographical memories in PD. Of particular interest for the current exploration, studies have showed that providing external cues is an effective way to overcome memory problems in PD (Buytenhuijs et al., 1994; Weingartner, Burns, Diebel, & Lewitt, 1984). For example, Sagar et al. (1988) showed that giving cues at retrieval helped participants with PD to retrieve previously generated personally experienced events. Participants were first presented with ten cues (bird, car, boy) and asked to give personal events. The following day, participants were then presented with the cue words again and asked to recall the events generated the day before. Then, if participants failed to regain memories generated on Day 1 they were cued again with key words, chosen by the experimenter, from their Day 1 memories. Results showed that when cued with specific key words, PD participants regained their Day 1 performance thus supporting the retrieval hypothesis. These studies thus support the idea that providing people with PD with specific cues should increase their retrieval.

In the current follow-up study, employing the well-established autobiographical fluency task (Dritschel et al., 1992), in the first stage of the experiment, participants were asked to retrieve AMs from five lifetime periods (Smith et al., 2010; Piolino et al., 2003). Based on our previous findings we predicted that participants with PD would retrieve fewer

specific memories especially from the most recent lifetime periods (Smith et al., 2010). After a delay, we asked them to retrieve the memories produced in the first stage in three different retrieval conditions: free recall, generative recall where we gave the lifetime periods as cues, and finally specific recall where we gave participants cues corresponding to titles that they themselves gave to their AMs produced in the first stage of the experiment. Compared to Sagar et al.'s (1988), the novelty of this study was not only to use lifetime periods as cues but also in the second stage of the experiment to have a free recall phase where participants were not given any cues when asked to recall the information. Our prediction based on previous findings issued from the memory literature (Kliegel, Altgassen, Hering, & Rose, 2011; Price, 2010) and from Sagar et al.'s (1988), is that overall patients will benefit from being given cues. However, we also predict that PD participants will benefit more from specific cues than generic cues because retrieval processes involved when specific cues are available involve less strategic processes.

2. Method

3.

Participants

Sixteen participants with idiopathic Parkinson's disease (9 females) were recruited through the Leeds (UK) branch of the Parkinson's Society. The diagnosis of Parkinson's disease was established by a neurologist in accordance to the clinical criteria of the United Kingdom Parkinson's disease Society Bank (UK, PDSBB; Gibb & Lees, 1988). Sixteen age matched older adults controls (OAC, 11 females), free of neurological or psychiatric illness were recruited from the University of Leeds Adult pool. All were native English speakers and had received at least 8 years of education. Demographic characteristics are reported in Table 1. Exclusion criteria for both groups included dementia (Mini-Mental State Exam score <26, MMSE, Folstein, Folstein, & McHugh, 1975), a history of traumatic brain injury or neurological disorder other than PD, medications known to affect cognitive function (e.g., anticholinergics, antidepressants, antipsychotics), a history of alcohol or drug abuse, or a psychiatric disorder.

Furthermore, given that depression itself leads to deficits in AM (Williams et al., 2007), only participants without severe depression (Geriatric Depression Scale score, Sheikh & Yesavage, 1986) were included. There were no significant differences between the two groups for age ($t(30) = 0.30, p = .77$) and MMSE score ($t(30) = 0.59, p = .56$). Participants also completed two standardized tests of executive function: the Trail Making Task and the Stroop task. The Stroop task (Stroop, 1935) required participants first to read words that pertain to different colours for example red, printed in black ink and then to read colour words written in incongruent colours for example the word RED written in blue ink. The outcome measure was the interference that is the time it took to complete the control conditions compared with the interference condition. The Trail Making Task (TMT; Reitan, 1958) comprises two parts: Part A in which the subject is asked to quickly draw lines on a page connecting 25 consecutive numbers and Part B in which the subject must draw the lines alternating between numbers and letters. The errors and the time to complete Part B minus Part A were recorded. There were no group differences on the Trail Making Task time scores (PD: $M = 75.95, SD = 53.47$; OAC: $M = 46.31, SD = 38.02$), or the TMT error scores (PD: $M = 0.81, SD = 1.37$; OAC: $M = 0.44, SD = 1.50$). There were

also no significant differences on the Stroop task (PD:M = 28.00, SD = 35.11; OAC:M = 14.38, SD = 10.53).

At the time, the PD patients had been diagnosed for an average of 8 years (SD = 16.28). The motor part III of the Unified Parkinson's Disease Rating Scale (UPDRS: Fahn & Elton, 1987) was administered (M = 26.18). Only patients suffering from a mild (n = 8) to moderate (n = 8) rigid-akinetic form of PD were included as rated by Hoehn and Yahr's (1967) scale (M = 2.9). All patients were on antiparkinsonian medication and all patients continued their routine medication regimens (l-Dopa) when tested.

The study was performed in accordance with the ethical standards specified in the 1964 Declaration of Helsinki. Consent was obtained and the study was approved by the Ethical Committee of the University of Leeds (UK).

[Insert Table 1]

Materials and procedure

The experiment comprised two parts. In the first part, participants generated Autobiographical memories. There was then a delay period lasting 20 min in which neuropsychological tests were administered, including the tests of executive function. Part two was a three phase recall period.

Part 1: Autobiographical memory task

The autobiographical fluency task was similar to the task proposed by Dritschel et al. (1992) and used in Smith et al. (2010). Participants were given three minutes to recall autobiographical memories from a given epoch. Five lifetime periods were used; 0–18 years (Period A), 19–30 years (Period B), over 30 up until the last 5 years (Period C), the last 5 years excluding the last 12 months (Period D) and the last 12 months (Period E; see Piolino et al., 2003). For each epoch participants were given 3 min to recall personal events from that time period. It was indicated to the participants that personal events consist of: Specific memories lasting no longer than 1 day describing what happened, what you did and felt, the circumstances, with whom, where and how it happened. To clarify participants were instructed: 'If you are recalling a holiday at the seaside, for example, you must avoid general descriptions, giving precise memories of a particular event which happened on a particular day during that holiday'. After each personal event was given, participants were told that the event should be given a short title which is personal to them and relevant to the event. For example, 'First trip to Skegness'.

The personal events generated were classified as either general or specific for the purposes of analysis. Specific events contained event-specific knowledge (ESK) and were located within a time sequence of less than 24 hrs. Memories that did not meet these requirements were considered general (i.e., a generalized narrative lasting more than 24 hrs or events fused together). The total number of specific events and the total number of general events were examined in the analysis (Smith et al., 2010).

Part 2: Recall of AMs after a delay

The tasks were administered in the order in which they are presented.

Free recall phase. Participants were instructed to recall the personal events given in Part 1 in exactly the way that they originally described. There was no time limit and responses were audio recorded.

Lifetime period cued-recall phase. Participants were given, as an audio cue by the researcher, the lifetime periods as general cues to retrieve the personal events they had given earlier. They were instructed to describe the personal events, in exactly the way they were originally described, in response to the given epoch. The lifetime period cues were given in chronological order. There was no time limit and responses were audio recorded.

Self-generated titles cued recall phase. Participants were given, as an audio cue by the researcher, the memory titles they had assigned to each personal event (in chronological order). They were instructed to describe the personal events, in exactly the way they were originally described, in response to the memory title. There was no time limit and responses were audio recorded.

In each phase, the total number of personal events correctly recalled from Part 1 was recorded. The personal events that were retrieved were classified as specific or general, according to the distinction outlined above. The number of specific and general events recalled at each retrieval phase is also reported in the analysis (Smith et al., 2010).

Results

Autobiographical memory task

This first section of the results concern Part 1 of the experiment, that is the AM task. The total number of AM generated, the number of specific and general AM retrieved were analysed separately.

Total number of AMs retrieved

A 2 (Group) 9 5 (Lifetime periods) ANOVA on the total number of memories recalled indicated that there was no significant effect of Group [$F(1, 30) = 0.12, p = .73, \eta^2 = .004$]. There was a significant effect of Time [$F(4, 120) = 8.01, p = .00$

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$\eta^2 = .211$], with both groups recalling most memories at remote time periods. There was no significant Group 9 Time interaction [$F(4, 120) = 0.25, p = .91, \eta^2 = .008$].

Number of specific AMs retrieved

A 2 (Group) 9 5 (Lifetime periods) ANOVA was conducted on the number of specific memories recalled in each period. There was no main effect of Group [$F(1, 30) = 1.18, p = .28$]. There was an effect of Time with both groups recalling most memories in Period B [$F(4, 120) = 3.61, p = .010$]. There were no significant interactions [$F(4, 120) = 0.24, p = .92$]. As group differences were predicted one-tailed t-tests were conducted for each lifetime period separately. There were no significant group differences regarding the total number of significant events recalled for Period A [$t(30) = 0.74, p = .23, d = .264$], B [$t(30) = 0.58, p = .28, d = .206$], C [$t(30) = 0.129, p = .10, d = .0458$], or D [$t(30) = 0.50, p = .31, d = .177$]. A trend towards significance on Period E [$t(30) = 1.34, p = .09, d = .473$] was observed with PD patients retrieving fewer specific memories than controls (see Table 2).

[Insert Table 2]

Number of general AMs retrieved

A 2 (Group) 9 5 (Lifetime periods) ANOVA was also conducted on the number of general memories recalled. There was no significant effect of Group, but there was a trend towards significance with the PD group recalling more general memories [$F(1, 30) = 2.84, p = .10$]. However, there was an effect of Time [$F(4, 120) = 2.79, p = .03$], with fewer general memories recalled in recent periods for both groups. There was no significant interaction [$F(4, 120) = 0.53, p = .71$] (see Table 2).

Effect of delay

Effect of delay on total number of AMs

To assess the impact of the delay period on participants ability to retrieve AMs, a 2 (Group) 9 2 (Total Events Part 1, Total Events Free Recall Part 2) ANOVA was conducted on the Total number of events generated. Overall there was an effect of delay, with the performance of both groups worse after the delay [$F(1, 30) = 110.68, p = .00$] (see Figure 1). There was no significant effect of group [$F(1, 30) = 1.66, p = .21$], but there was a significant interaction [$F(1, 30) = 5.00, p = .03$].

[Insert Figure 1]

Between group t-tests indicated that there was no group difference on memory performance before the delay [$t(30) = 3.45, p = .73, d = .122$] but there was a significant group difference after the delay [$t(30) = 2.31, p = .03, d = .814$] with the PD group performing worse than controls.

Effect of delay on number of specific AMs

Similarly, a 2 (Group) 9 2 (Specific Events Part 1, Specific Events Free Recall Part 2) ANOVA was conducted to investigate the effect of the delay on the number of Specific events retrieved. Overall there was an effect of delay, with the performance of both groups worse after the delay [$F(1, 30) = 30.00, p = .00$] (see Figure 1). There was no significant effect of group [$F(1, 30) = 2.46, p = .13$] and no interaction [$F(1, 30) = 0.96, p = .33$].

Effect of delay on number of general AMs

The same 2 9 2 ANOVA analysis was conducted on the Total number of General Events generated compared with the number of General Events retrieved during free recall after the delay showed an effect of delay, with the performance of both groups worse after the delay [$F(1, 30) = 30.00, p = .00$] (see Figure 1). No significant effect of group emerged [$F(1, 30) = 0.54, p = .46$]. There was a significant interaction [$F(1, 30) = 9.33, p = .01$]. Between group t-tests indicated that there were no group differences before [$t(30) = 1.68, p = .10, d = .596$] or after the delay [$t(30) = 0.60, p = .55, d = .212$].

Effect of cuing

Effect of cueing on total number of AMs

To establish whether there was an effect of cueing on the total number of events retrieved a 2 (Group) 9 3 (Recall condition: Free Recall, Lifetime Cue, Self-generated

Title Cue) ANOVA was conducted. The ANOVA indicated that there was a significant effect of the type of cue [$F(2, 60) = 79.41, p = .00$], with most events recalled when participants are cued with the Self-generated titles (see Figure 2). There was a significant effect of Group [$F(1, 30) = 4.53, p = .04$] with the PD group recalling fewer events and a trend toward a significant interaction [$F(2, 60) = 3.00, p = .06$]. Between group t-tests indicated that there were significant group differences between the total number of events given at Free Recall [$t(30) = 2.31, p = .03, d = .814$] and when Lifetime period cues were given [$t(30) = 3.09, p = .00, d = 1.09$], but there was no significant group difference when Self-generated cues were given [$t(30) = 1.02, p = .31, d = .361$].

Effect of cueing on number of specific AMs

A similar 2 (Group) 9 3 (Recall condition: Free Recall, Lifetime Cue, Self-generated Title Cue) ANOVA was conducted on the number of Specific events. The ANOVA showed a significant effect of condition [$F(2, 60) = 47.93, p = .00$], with most events recalled when participants are cued with the Self-generated titles (see Figure 2). There was a significant effect of Group [$F(1, 30) = 4.34, p = .04$] with the PD group recalling fewer events and no significant interaction [$F(2, 60) = 0.83, p = .44$].

[Insert Figure 2]

Effect of cueing on number of general AMs

A slightly different pattern was observed on the 2 (Group) 9 3 (Recall condition: Free Recall, Lifetime Cue, Self-generated Title Cue) ANOVA for General events. The ANOVA indicated that there was a significant effect of the type of cue [$F(2, 60) = 57.82, p = .00$], with least events recalled when participants are cued with the Self-generated titles (see Figure 2). These findings suggest that it is specific rather than general memories that contribute the increase in the total AMs given when self-generated cues are provided. There was no significant effect of Group [$F(1, 30) = 0.01, p = .91$] and a significant interaction [$F(2, 60) = 6.57, p = .00$]. Between group t-tests indicated that there were no significant group differences at Free Recall [$t(30) = 0.60, p = .55, d = .212$] and when Lifetime period cues were given [$t(30) = 0.49, p = .63, d = .174$], or when Self-generated cues were given [$t(30) = 0.82, p = .41, d = .431$].

4. Discussion

This study examined the retrieval of autobiographical memory in Parkinson's disease, with a view to investigating the effect of providing cues to support autobiographical memory retrieval. Previous findings in the literature suggest that people with Parkinson's disease tend to retrieve overgeneral non-specific autobiographical memories (Smith et al., 2010). For example, instead of recalling a specific incident (I remember one time going on holiday to Blackpool and riding in a horse and carriage down the main street with my grandparents in the rain), people with PD tend to recall more general memories (I remember we used to go on holiday to Blackpool). Whilst the first part of our experiment supported this idea as the PD group generated fewer specific AMs for the most recent lifetime periods, the group differences were not as clear as previously observed. This could be due to methodological differences between the two experiments. In particular participants were given more time to generate AMs in the current experiment and were asked to produce titles for each event they recalled. The titles could have served as a prompt or cue to provide a more detailed account of the

event. The main focus of this study was to explore the hypothesis that failure to generate AMs in PD can be accounted for by a retrieval deficit. In this study participants were asked to recall AMs they had previously generated in different conditions: a free recall condition, a cued-recall condition using generic cues (lifetime periods) and a cued-recall condition using specific cues (self-generated titles). All of the AMs retrieved were classified according to their specificity (i.e., Specific or General).

The results showed that after the delay period whilst both groups retrieved significantly fewer events, the PD group retrieved significantly fewer events in total than the control participants. This deficit persisted when the PD group was given generic cues (lifetime periods) to facilitate retrieval. A key finding of this study was that when specific self-generated cues (titles) to retrieval were provided, no group differences were apparent. One of the features of our findings was that the type of cue presented had different facilitatory effects on retrieval after the delay. The self-generated cues improved retrieval to a greater extent than the generic cues for both groups. This reflects the findings of Sagar et al. (1988) who showed that after a delay period of 1 day participants with Parkinson's disease had difficulty retrieving memories that they had previously generated, these deficits were ameliorated when presented with key words from their memories as cues.

There may be several explanations for these findings. Firstly, this finding can be explained with reference to the Self-Memory Model of autobiographical memory (Conway, 2005) in which providing generic and specific cues initiates different routes to AM retrieval. Generative retrieval involves engaging in a search elaboration process using cues to probe memory for event-specific information. This will occur when nonspecific cues such as common nouns (i.e., Crovitz cueing paradigm, Crovitz & Schiffman, 1974) or topics and lifetime periods (Kopelman, Wilson, & Baddeley, 1989) are provided, as these cues do not provide direct information about previously stored memories. In contrast, direct retrieval refers to being provided with specific information, relevant to the goals of our working self (self concept; Conway & Pleydell-Pearce, 2000), such that it activates access to a memory without the need to engage in a search process. In this sense providing specific AM cues, such as have been previously generated or contain self relevant information (i.e., Sagar et al., 1988), may provide a route to direct retrieval. As direct retrieval does not involve a search-elaboration process, it is less cognitively demanding than generative retrieval (Conway, 2005). Thus, providing generic cues to initiate generative retrieval is not sufficient to support the retrieval of autobiographical memory in Parkinson's.

The finding can also be explained by the similarity between semantic and autobiographical memory tasks (Nyberg et al., 2002). In particular, similar brain regions seem to be recruited by generative AM retrieval and semantic retrieval and include mainly bilateral ventral PFC (Nyberg et al., 2002). This, according to Thompson-Schill et al. (1997), would result from the fact that both tasks require participants to select from competitive alternatives. In the PD literature, many studies have shown semantic memory deficits in Parkinson's disease particularly on fluency tasks (see Henry & Crawford, 2004 for a review). In other words, reduced generative retrieval capacity in PD could be related to a difficulty in selecting the semantic cue to guide retrieval.

Additionally, the findings fit with the literature showing that PD patients have difficulties in retrieving contextual information (i.e., recollection). Studies examining source memory indicate deficits in PD when participants are asked to judge whether an item was generated by themselves in saying or in thinking (Hsieh & Lee, 1999), when asked to judge the temporal order (Vriezen&Moscovitch, 1990) or asked to remember the gender of the speaker (Drag, Bieliauskas, Kaszniak, Bohnen, & Glisky, 2009). Several studies have indicated that Parkinson's disease is characterized by a lack of recollection, especially in moderate PD (Hay, Moscovitch & Levine, 2002; Edelstyn, Shepherd, Mayes, Sherman, & Ellis, 2010; Edelstyn, Mayes, Condon, Tunnicliffe, & Ellis, 2007; but see Weiermann et al., 2010).

Finally, the findings also fit with the literature regarding prospective memory function in Parkinson's disease in which participants show deficits when specific focal cues to regarding the prospective memory task (i.e., to prompt an action to be performed) are not provided (see Kliegel et al., 2011 for review). For instance, if the PMcue is the word "dog" and its features (i.e., specified word) are embedded in an ongoing task such as a lexical decision task, this provides a specific cue to action (Marsh, Hicks, Cook, Hansen,&Pallos, 2003). However, if the PMtask is to detect a word belonging to the category of animals, but the cue (the word) is not specified, this provides a generic (non-focal) cue.

To conclude, autobiographical memory has long been considered to play a vital role in the construction and maintenance of self-identity (Conway, 2005). Autobiographical memory plays a crucial role in everyday life and is for example central in daily activities such as conversing and decision making (Bluck et al., 2005). The limited research on autobiographical memory in PD and the clear importance of AM in everyday life strongly motivate further studies on this topic. Furthermore, several studies suggest a great deal of overlap between the retrieval of past AMs and the imagining of future events. In other words, autobiographical memories allow individuals to project themselves in the future (D'Argembaud&Van der Linden, 2004; Williams et al., 1986). Of particular interest to our study, clinical populations who show reduced AM specificity, such as suicidally depressed individuals, also have a reduction in specificity of future events. de Vito et al. (2012) recently demonstrated that these people with Parkinson's disease generate fewer future events than controls. These findings are coherent with the reduced specificity of AMs observed in PD and suggest that improving AMs retrieval might lead to people with Parkinson's being able to better able to maintain their identity in the future. Finally, many authors have suggested that because AM retrieval involves a broad range of cognitive processes (search processes, monitoring and control processes, visual imagery, selfreflection, executive functions), it is thus not surprising that recalling AM involves such a distributed network of brain regions (Cabeza & St Jacques, 2007; Svoboda et al., 2006). However, determining exactly which brain regions contribute to AM impairments in Parkinson's disease remains a challenge for future research.

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Table 1: Participant demographics (means and standard deviations)

	PD	OAC
	(n=16)	(n=16)
Age	75.18 (8.57)	74.51 (7.86)
Mini Mental State Examination	28.25 (1.69)	28.56 (1.56)
Geriatric Depression Scale	3.54 (2.56)	2.31 (1.53)
Years of Education	10.87 (1.71)	12.63 (3.01)

Table 2: Total, specific and general number of memories recalled over lifetime periods A-E

	Parkinson's disease (n=16)	Older adult controls (n=16)
Total A	3.86 (1.14)	4.06 (1.52)
Specific A	2.19 (1.42)	2.56 (1.41)
General A	1.69 (1.30)	1.50 (1.26)
Total B	3.56 (.72)	3.56 (2.1)
Specific B	2.36 (.88)	2.75 (2.40)
General B	1.19 (.91)	.81 (.65)
Total C	3.38 (.95)	3.31 (1.45)
Specific C	2.12 (1.09)	2.69 (1.35)
General C	1.25 (9.3)	.62 (.71)
Total D	2.62 (1.2)	2.87 (1.36)
Specific D	1.63 (1.31)	1.86 (1.50)
General D	1.00 (.96)	1.00 (.81)
Total E	2.94 (1.34)	3.25 (1.61)
Specific E	1.63 (1.08)	2.31 (1.74)
General E	1.31 (1.01)	.94 (.85)

NB: Period A (0-18 years), Period B (18-30 years), Period C (30-Last 5 years), Period D (last 5 years-Last 12 months) and Period E (last 12 months). *p<.05

Figure 1: Number of events recalled pre and post delay period

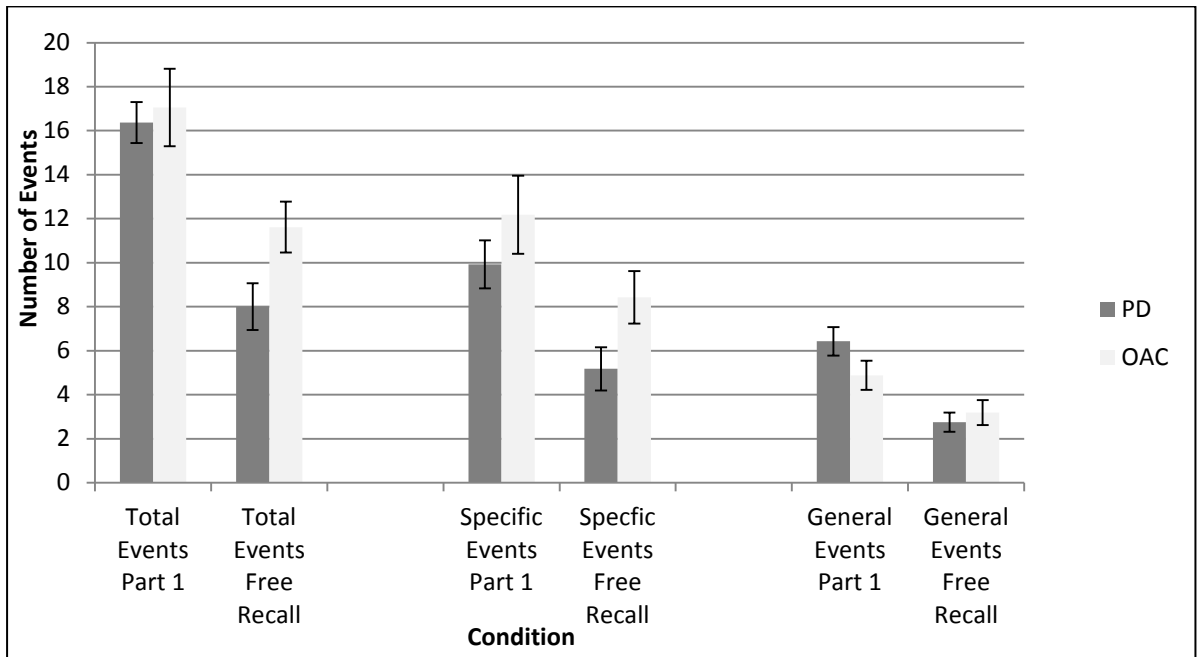


Figure 2; Number of events recalled under different cueing conditions after delay period

