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# Consciousness and Cognition

journal homepage: [www.elsevier.com/locate/concog](http://www.elsevier.com/locate/concog)

## Subjective states associated with retrieval failures in Parkinson's disease

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### ARTICLE INFO

#### Article history:

Received 11 February 2013

Available online 30 May 2013

#### Keywords:

Memory

Subjective states

Feeling-of-knowing

Tip-of-the-tongue

Parkinson's disease

### ABSTRACT

Instances in which we cannot retrieve information immediately but know that the information might be retrieved later are subjective states that accompany retrieval failure. These are expressed in feeling-of-knowing (FOK) and Tip-of-the-tongue (TOT) experiences. In Experiment 1, participants with Parkinson's disease (PD) and older adult controls were given general questions and asked to report when they experienced a TOT state and to give related information about the missing word. The PD group experienced similar levels of TOTs but provided less correct peripheral information related to the target when in a TOT state. In Experiment 2, participants were given a Semantic (general knowledge questions) and an Episodic (word pairs) FOK task. PD patients failed to accurately predict their future memory performance (FOK) in response to both episodic and semantic cues. Results are interpreted in the context of recent frameworks of memory and metacognition.

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### 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. Studies investigating memory in PD have compared two main systems: the episodic memory system and the semantic memory system (Tulving, 1985). Episodic retrieval is characterized by a recollective experience and a feeling of the self in the past (Tulving, 1985). Semantic retrieval is associated with noetic awareness (familiarity and knowing) and reflects conceptual knowledge. Studies in Parkinson's disease have revealed impairments in episodic memory, particularly on free recall tasks (Daum et al., 1995; Gabrieli, Singh, Stebbins, & Goetz, 1996; Jonhson, Pollard, Vernon, Tomes, & Jog, 2005; Whittington, Podd, & Stewart-Williams, 2006; see Dujardin and Laurent 2003 for a review). Similarly, many studies have showed semantic memory deficits in Parkinson's disease particularly on fluency tasks (see Henry and Crawford 2003 for a review).

Whilst many researchers have suggested that memory problems in PD are associated with difficulties retrieving information, not many studies have actually explored the subjective states associated with retrieval in this clinical population. Subjective states differ according to the type of memory task involved (episodic versus semantic) as well as the retrieval outcome. Subjective states can either accompany retrieval success or emerge following a retrieval failure. In the case of a retrieval success, subjective states might be captured by the type of contextual information that participants can recall, such as where or when the information was presented (i.e. recollection). On the other hand, when people fail to retrieve the information they might infer that they still might retrieve the answer. Instances in which we cannot retrieve information immediately but know that the information will or might be retrieved later are the subjective states that accompany retrieval

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failure. These subjective states can be expressed in feeling-of-knowing (FOK, Hart, 1965) and Tip-of-the-tongue (TOT, Brown & McNeill, 1966) experiences.

Most studies in Parkinson's disease have assessed subjective states associated with retrieval success and suggest that impairments vary according to the severity of the disease (Edelstyn, Mayes, Condon, Tunnicliffe, & Ellis, 2007; Edelstyn, Shepherd, Mayes, Sherman, & Ellis, 2010; Hay, Moscovitch, & Levine, 2002; but see Weiermann, Stephan, Kaelin-Lang, & Meier, 2010). However, studies measuring subjective states of retrieval failure in Parkinson's disease are scarce. The novelty of this study is to explore these subjective states of retrieval failure in Parkinson's disease by combining both the TOT and the FOK paradigm in two experiments.

A Tip-of-the-tongue (TOT) state is the feeling that a currently inaccessible item will later be recalled (Brown, 2012; Brown & McNeill, 1966). From a linguistic perspective, TOTs signal a *partial retrieval failure* where semantic information is available, but participants fail to phonologically retrieve the word. TOTs can also be considered from a metacognitive perspective (Bacon, Schwartz, Paireficout, & Izaute, 2007). Metacognition refers to higher level cognitive processes consisting of a reflection upon the cognitive level (Nelson & Narens, 1990). From a metacognitive perspective, TOTs signal a *partial retrieval success*; the partial information retrieved leads participants to experience a TOT. In other words, TOTs are subjective experiences that allow individuals to monitor their retrieval processes (Schwartz, 2002). An inaugural study published by Matison, Mayeux, Rosen, and Fahn (1982) showed that PD patients experienced word-finding difficulties, thus suggesting that patients were demonstrating some TOT-like states. However, in this study TOT states were not directly measured and patients were not asked to report when they were experiencing a TOT. In a more recent study, Oh-Lee, Szymkowicz, Smith, and Otani (2012) directly measured TOT states using 30 general knowledge questions. Participants could give three different answers for each question: the answer they thought was correct, a 'do not know' answer and a TOT answer. In the case of a TOT answer, participants were asked to report the strength of their TOT experience on a scale of 1–20. Participants with PD were found to experience the same number of TOT states as the older adults controls. TOT accuracy was measured using a Gamma correlation comparing the TOT states (using the scale) and the memory performance (Nelson, 1984). The gamma correlation is an index of the rank order agreement between the metacognitive judgements (e.g. TOT or FOK) and memory performance (Nelson, 1984). The index is based on the difference between the concordant (e.g. I think I know the word (strong TOT) and I later recognize it) and discordant (I think I know the word (strong TOT) and I do not recognize it) pairs. No significant group differences were observed.

Feeling-of-knowing judgments (FOK, Hart, 1965) are predictions about the likelihood of subsequent recognition of currently non-recalled information (Hart, 1965; Nelson & Narens, 1990). In a FOK experiment participants are presented either with new information to learn such as word pairs (episodic memory task) or are presented with general knowledge questions such as 'what is the capital of France?' (semantic memory task). When presented with the question or the first word of the pair they are then asked to recall the corresponding information. If they cannot recall the information, they are asked to predict whether or not they will be able to recognize the missing information if it is presented to them later. This prediction is a FOK judgment. Thus, FOK judgments measure participants' ability to estimate the likelihood that they will recognize a piece of information they have failed to recall either from semantic memory (e.g. Nelson & Narens, 1990), or from episodic memory (e.g. Schacter, 1983; Souchay, Isingrini, & Espagnet, 2000). The most notable difference between the Episodic FOK and Semantic FOK tasks is that the former involves a study phase, so that FOK judgments are made on recently encountered material. On the other hand, Semantic FOKs are made about information assumed to be already stored in memory. A consistent finding is that Parkinson's patients give inaccurate FOKs on episodic tasks (Baran, Tekcan, Gurvit, & Boduroglu, 2009; Souchay, Isingrini, & Gil, 2006; Yu, Wu, Tai, Lin, & Hua, 2010). For instance, Souchay et al. (2006) gave participants a list of 20 word pairs to learn and during recall asked them to give a Yes/No FOK judgment when presented with the cue. The results showed that participants with PD were inaccurate at predicting their memory performance. On the other hand, only one study has yet looked at FOK judgments in PD using a semantic memory task (general knowledge questions). Coutler (1989) compared depressed and non-depressed PD groups, finding that non-depressed participants with PD gave accurate FOKs. However, we interpret Coutler's findings with caution since they were published as an abstract and the methodological details of the exact paradigm used were not provided.

These studies suggest that patients with PD demonstrate accurate subjective states associated with retrieval failure (TOT and FOK) when assessed on a semantic memory task (Coutler, 1989; Oh-Lee et al., 2012) but that they are inaccurate when assessed on an episodic task (FOK studies, Baran et al., 2009; Souchay et al., 2006; Yu et al., 2010). However, the neuropathological findings in PD support the prediction that all subjective states associated with retrieval failure might be impaired in this clinical population. Most reviews have focused on the dysfunction of prefrontal cortex as a predominant marker of the disease (e.g. Dujardin & Laurent, 2003; McPherson & Cummings, 1996; Owen, 2004; Prull, Gabrieli, & Bunge, 2000; Taylor, Saint-Cyr, & Lang, 1990; Troster & Fields, 1995). Dysfunction of prefrontal cortex is the consequence of a reduction in dopaminergic innervation of the basal ganglia and the frontal lobes (see Dujardin & Laurent, 2003; Lang & Lozano, 1998). Volumetric MRI studies in PD have also documented atrophy of the hippocampus in PD, even in patients without dementia (Bruck, Kurki, Kaasinen, Vahlberg, & Rinne, 2004; Tam, Burton, McKeith, Burn, & O'Brien, 2005). To summarize, studies in Parkinson's disease have shown decline of both the frontal lobes and the temporal lobes in Parkinson's disease. These correspond to the brain regions highly involved in TOT states or FOK judgments. For example, a set of fronto-temporal and anterior cingulate brain regions are activated during FOKs (Kikyo & Miyashita, 2004; Kikyo, Ohki, & Miyashita, 2002; Maril, Simons, Mitchell, Schwartz, & Schacter, 2003; Reggev, Zuckerman, & Maril, 2011; Schnyer, Nicholls, & Verfaellie, 2005). Similarly, fMRI studies exploring TOT states have revealed a crucial role of the frontal lobes. Maril, Wagner and Schacter

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