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Improving metamemory in ageing and Parkinson’s disease

SIR—Older adults and patients with Parkinson’s disease (PD) have significant but subtle deficits in memory and metamemory [1]. Metamemory refers to people’s knowledge, awareness and control of their memory [2]. A common method for measuring people’s knowledge of their memory abilities (‘monitoring’) is to ask individuals to predict how well they will remember items during an upcoming memory test. One such prediction method is the Feeling-of-Knowing (FOK), which consists in asking participants to predict the likelihood that they will subsequently recognise information they have failed to recall [3].

Coutler [4] and Ivory et al. [5] assessed the accuracy of FOK judgments on previously learnt material (semantic memory) indicating that FOK judgments remained accurate in PD. However, Souchay et al. [1], in a pioneering study assessing FOK on newly learnt information (episodic memory), revealed a deficit in PD. Patients were presented with cue-target noun pairs to learn and were asked to retrieve the target when presented with the cue at recall. FOK predictions were made on non-recalled targets. Results showed that PD patients were inaccurate at predicting their ability to retrieve forgotten targets.

These studies suggest a dissociation between impaired episodic FOK and preserved semantic FOK in PD, parallelizing findings observed in ageing and in patients with frontal lobe lesions [6]. As a result, episodic FOK inaccuracy in PD was interpreted as resulting from dysfunction of the frontal lobes, highly involved in metamemory [6].
The present study was an extension of our earlier work and aimed to determine whether or not FOK accuracy could be improved in older adults and in Parkinson's patients. According to the accessibility model proposed by Koriat [7], FOK judgments depend on the effort made during the retrieval process, whose by-product is used to evaluate the future ease of access to the answer [7]. Accordingly, FOK judgments are directly linked to the memory trace. An extension is that if you improve memory performance this should have a knock-on effect on FOK accuracy. The novelty of this research was to explore whether or not FOK accuracy could be improved in Parkinson's patients and older participants. We tested PD patients and matched older adults on a FOK task using action verbs in two conditions: a subject-performed task (SPT) and a reading condition. SPT conditions, whereby participants enact to-be-remembered material during encoding [8], have been shown to improve memory performance in healthy participants and in PD [9]. We thus predicted that memory and FOK accuracy would be better in the SPT condition. The null hypothesis states that enacting to-be-remembered material will have no effect of FOK accuracy.

Method

Participants
Sixteen people with idiopathic PD (men = 9 and women = 7) and 18 older adult controls (OAC) (men = 7 and women = 11) participated. All Parkinson's patients were diagnosed by a board-certified neurologist with speciality training in movement disorders.Only patients suffering from a mild rigid-akinetic form of PD were included (range = 1–2.5, M = 1.9, SD = 0.96) rated by Hoehn and Yahr's scale. The patients were neither demented, determined by the Folstein Mini-Mental Score Exam (MSE) [10] scores above 24 points, nor severely depressed, determined by the Geriatric Depression Scale (GDS) score [11] (M = 3.8, SD = 3.84). All OACs earned MMSE scores above 24 points. There were no significant differences between the groups for age, years of education and MMSE.

Material and procedure
Two lists of 30 cue-target word pairs were presented. Each list comprised of three types of target words: 10 action words which were read (Read condition), 10 neutral words which were read (Read condition) and 10 action words performed by the participants (SPT condition). The cue words were neutral. The words, matched for age of acquisition, imaginability, frequency, number of letters and number of syllables, were taken from the MRC Psycholinguistic database.

The episodic FOK procedure and recognition task used were similar to those used in previous studies on clinical populations [1, 12–15]. In the study phase, participants were presented with the 30 cue-target word pairs, at a rate of 8 s per pair, and told that their memory for the target word would be tested when presented with the corresponding cue. After the study phase, participants were asked to recall the target word that corresponded to a given cue. FOK predictions were made for non-recalled items. The FOK response was either ‘yes’ or ‘no’: when participants thought they would be able to recognise a target, they made a ‘yes’ prediction, and when they thought they would not be able to recognise a target, they made a ‘no’ prediction. Memory performance was measured by the recognition test immediately after the FOK phase. For this task, participants were shown the target words from the list, along with 30 distracter words (10 action, 20 neutral) in a randomised order. The words were presented individually, and participants were asked to indicate if the word was an ‘old’ word, that was on the study list, or a ‘new’ word. The number of words correctly identified as ‘old’ was recorded. The false alarm rate (i.e. new words identified as old) was not reported. As all of the SPT targets and Read targets were presented together, false alarms could not be assigned to each condition.

Results

Initial analyses showed no difference between action words and neutral words on measures of memory (recognition). Because there was no interaction of group and item type, we did not include this as a separate variable and collapsed the action and neutral (Read) words in the remaining analysis.

Memory measures

A two (SPT vs Read) by two (group) analysis of variance (ANOVA) was conducted on the proportion of words recognised (i.e. hit rate). Results indicated an effect of SPT [F(1,32) = 43.61, P < 0.001], as well as an effect of group [F(1,32) = 8.1, P < 0.05] on recognition performance. There was no interaction on the recognition scores [F(1,32) = 0.28, P = 0.59] (Figure 1).

Feeling-of-Knowing accuracy

FOK accuracy was operationalised by gamma correlations between FOK judgments and recognition performance [14]. Gamma correlations range from +1 to −1, with positive gamma correlations signifying more accurate predictions. There are two means of assessing gamma differences—one to enter gammas into an ANOVA to see if the gammas differ between groups and conditions. The other is to compare the gammas with zero—assessing whether the FOK predictions were reliably better than chance.

A two (SPT vs Read) × two (group) ANOVA was carried out. There were no significant effects of SPT [F(1,32) = 0.35, P = 0.56] or group [F(1,32) = 1.83, P = 0.19] and no interaction [F(1,32) = 0.17, P = 0.68]. To further investigate participants' FOK judgments, one sample t tests were carried out. Gammas in the PD group were not significantly different from 0 on the SPT [t(15) = 0.56, P = 0.58] or read [t(15) = 0.69, P = 0.5] tasks. The OAC gamma scores were not signifi-
significantly different from 0 on the read task \( t(17) = 1.68, P = 0.11 \); on the SPT task, the mean gamma was greater than 0 \( t(17) = 2.34, P < 0.05 \) indicating a stronger relationship between predictions and performance (see Figure 2).

**Discussion**

The aim of the current study was to establish whether FOK accuracy could be enhanced through improving memory performance in PDs disease and in older participants. Memory performance in both groups benefited from performing material at encoding (SPT). This supports the earlier findings of Knopf et al. [9] who found enactment improved memory performance in Parkinson’s patients.

Whilst the FOK accuracy enhanced in the OACs relative to chance in the SPT condition, we did not find enactment improved FOK accuracy in the PD group. Gamma correlations in the PD group were very low on this task. Whilst we did obtain an enactment effect on the memory task, it is plausible that memory performance in the PD group was
not enhanced sufficiently to improve access to the material in the memory trace, on which accurate FOK judgements are based. Gammas for the SPT were significantly above chance for the old participants. Whilst the finding that gamma in older adults under the Read condition was not above chance replicates previous studies showing Episodic FOK was sensitive to age [13,16]. These results show for the first time that FOK accuracy can be improved in older adults, i.e. by improving memory, one can also improve metamemory. However, further research needs to address the influence of the FOK paradigm and the recognition paradigm used as these factors might influence the findings.

To conclude, this research could have implications for memory rehabilitation. Indeed, despite our findings not showing improved FOK accuracy in PD, there is evidence that by enhancing memory performance at encoding, we can improve metamemory in ageing. Evidence from clinical populations indicates that individuals who are more aware of their memory performance are more likely to benefit from memory rehabilitation [17]. In light of this, further research should examine whether enhancing metamemory in normal ageing can be extended to clinical groups. Finally, from a rehabilitation point of view, other memory-improvement techniques, as well as practice effects, should be assessed to improve memory awareness in clinical populations [18].

**Key points**
- This study aims to investigate memory awareness (i.e. metamemory) using the FOK paradigm on a SPT in PD.
- The accessibility model [7] suggests that FOK accuracy is linked to the strength of the memory trace.
- Enactment improves memory in Parkinson’s patients [9].
- Individuals who are more aware of their memory performance are more likely to benefit from rehabilitation [17].
- FOK accuracy was improved in older adults but not in PD patients on the SPT.

**Conflicts of interest**
None.

**References**

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**Finding the right outcome measures for care home research**

SIR—The authors of this report conducted a cluster-randomised trial investigating the efficacy of a rehabilitation intervention on the functional independence and mobility of UK care home residents versus a control sample who received standard care [1].

When selecting outcome measures for the trial, it was relatively easy to identify self or proxy report activities of daily living (ADLs) and mobility measures that had well-