Computerized Self-Ordered Working Memory Performance in Non-demented Parkinson Disease

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Background

Parkinson's disease (PD) without dementia or depression has been associated with executive dysfunction including visual working memory deficits, related to dopamine depletion and dysregulation of fronto-striatal circuitry. Medication with dopaminergic agents in PD has in some cases shown to alleviate these working memory impairments, although this finding has not been consistent.

Petrides' (1982) Self-Ordered Pointing Task (SOPT) has been used to investigate strategic working memory in many groups, including medication-withdrawn PD (Gabrieli et al., 1996) and PD "on meds" (West et al., 1998). The latter study did demonstrate visual working memory impairment in medicated PD patients vs. controls, suggested by the authors to be related to a deficit in task monitoring.

Because the SOPT is a self-paced task, one potential confound accounting for this latter finding is feasibly longer response times per trial in PD patients vs. controls. PD is associated with psychomotor slowing, and longer response times may lead to more forgetting errors due to greater working memory maintenance demands.

Study Aims

We first aimed to determine whether early to moderate PD, while ON dopaminergic medication, is associated with a visual (non-spatial) strategic working memory deficit, using a new, computerized version of the Self-Ordered Pointing Task (SOPT) and abstract geometric forms for stimuli.

Hypothesis: **PD patients will perform worse than younger and older controls (more SOPT errors, lower SOPT span).**

Second, we intended to examine the association of SOPT visual working memory performance (errors, span) with psychomotor speed and interference (within-task SOPT measures and traditional neuropsychological tests).

Hypothesis: **SOPT visual working memory performance in PD will be associated with slower response times and slower speed of processing, but not interference.**

Methods

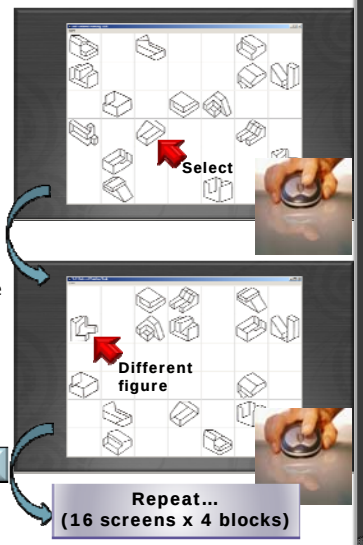
	Parkinson	Older Controls	Younger Controls
M/F	23/8 (N=31)	7/12 (N=19)	15/6 (N=21)
Age	57.9 (8.7)	61.6 (7.5)	21.1 (1.0)*
Yrs Education	15.1 (3.0)	15.6 (3.1)	15.3 (0.9)
Yrs Symptoms	11.0 (range 3-21)	-	-
UPDRS Motor	24.0 (range 10-53)	-	-
Hoehn-Yahr	II-III	-	-
Levodopa Meds	ON	-	-

*p<.05; yellow highlight signifies statistical equivalency across groups

Groups screened for cognitive impairment (MMSE, HVLT, BNT), mood disorders (BDI-2, STAI), other neurological conditions/neurosurgery, and adequate motor control while using a computer mouse. PD patients completed a neuropsychological battery, and all groups completed the SOPT (described below). UPDRS Motor score = OFF meds.

Computerized SOPT

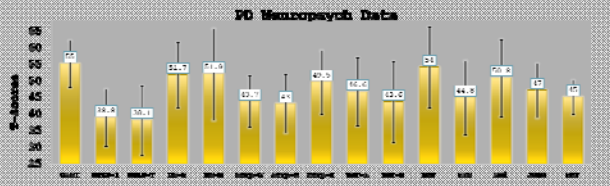
1. The participant selects one new, abstract object (of 16 possible) with the mouse (top screen).
2. The objects scramble spatially (1 sec delay), and a new novel object must be selected. Participants continue until a "block" of 16 screens/trials is complete. A perfect block score = selecting each of the 16 objects once.
3. Four blocks are completed with breaks of 30 seconds between blocks.



SOPT Dependent Variables

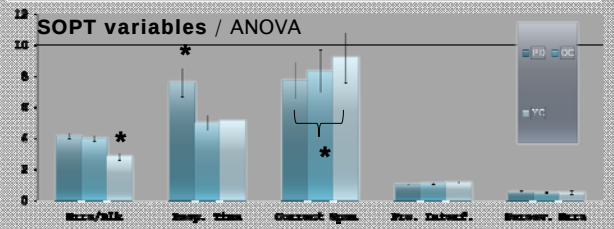
- **Error:** object is selected but it has already been selected in the current block.
- **Perseveration Error (PE):** the same object is selected twice in a row (included – overall error count).
- **Proactive interference:** ratio of total errors in the last two blocks to the total errors in the first two blocks (higher = more interference).
- **Span:** number of novel selections before the 1st error is made (block).
- **Response time (RT):** average response time per trial per block.

Results



	PD	OC	YC
SOPT Variables / ANOVA			
Errors per Block	4.12 (1.03)	3.97 (.80)	2.80 (1.08)*
Response Time (s)	7.59 (5.12)*	4.98 (2.10)	5.10 (2.22)
Perseverative Errors	.53 (.40)	.48 (.27)	.48 (.49)
Correct Span	7.73 (1.97)**	8.30 (1.80)	9.18 (2.01)**
Proactive Interference	1.03 (.58)	1.09 (.46)	1.13 (1.05)

* Significantly different from the other two groups (p<.05)
** Significantly different from each other (p<.05)



p < .05

- PD and OC made more errors than YC
- PD was slower to respond than OC or YC
- PD had a shorter initial correct span than YC

Regression analyses revealed that neither neuropsychological measures of processing speed nor interference contributed to SOPT performance. Clinical measures of mood and disease severity did not correlate with SOPT performance, but age did (negatively).

Conclusions

A software-based version of the SOPT was used to determine whether strategic visual working memory impairment in on-meds PD can be accounted for by group differences in response time on the task.

PD patients were found to be slower to respond on the task, but surprisingly, PD = OC on untimed SOPT variables (floor effect unlikely). Digit Span scores were also intact as a group.

These findings may relate to a growing body of research suggesting that storage aspects of visual working memory performance may improve with dopaminergic medication in PD, although this likely depends on several interacting factors including (1) stimulus / task demands, disease severity, genotype, and dopaminergic treatment (Cools et al., 2001; Frank, 2005; Rowe et al., 2008).

Future studies using the computerized SOPT will address these questions by adjusting stimulus parameters and testing PD patients off and on medication.