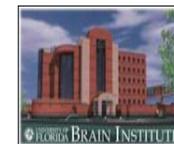


Clinical Utility of the “N-back” task in Detection of Working Memory Impairment in Parkinson’s Disease

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RATIONALE

The N-back is a working memory (WM) task that has been frequently used in neuroimaging studies, but has not yet been validated within the domain of clinical neuropsychological assessment. Because it parametrically varies WM load while keeping overall task procedures constant across conditions, it may potentially be a sensitive measure for detection of WM impairment in neurological populations.

OBJECTIVE 1

To learn whether patients with Parkinson’s Disease (PD) would display significantly lower accuracy on the n-back relative to controls. We predicted this result based on prior studies finding WM impairments in PD.

OBJECTIVE 2

To learn whether the N-back could better distinguish between PD patients and controls than a commonly used WM task, digit span backwards. We used discriminant function analyses to examine this objective.

BACKGROUND

- PD patients have been found to exhibit deficits in executive functioning (Downes et al., 1989; Owen et al., 1992)
- One aspect of executive function is **working memory (WM): actively maintaining and manipulating information in memory in order to guide contextually appropriate behavior** (Baddeley, 1986)
- The more widely used neuropsychological tests (i.e., PASAT, digit span, WAIS-III Arithmetic) are often dependent upon other abilities, such as arithmetic skill and speed.
- In contrast, the N-back task parametrically varies working memory load so that effect of load on accuracy and reaction can be parceled out, and includes a condition with no memory load (to control for level of attention/vigilance).
- For this reason, the N-back may be a more sensitive measure than traditionally used working memory tasks.)

PARTICIPANTS

Demographics

	Sex (male:female)	Age	Yrs. Ed	MMSE	GDS
PD patients	17:4	61.1	15.8	28.4	5.0
(n=21)		(8.6)	(3.0)	(1.4)	(4.5)
Controls	10:7	60.0	15.8	29.2	2.5
(n=17)		(10.9)	(2.9)	(0.8)	(2.8)

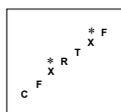
- PD patients had an average Hoehn-Yahr rating of 2.6 (0.46) and with an average disease duration of 10.5 (7.7) years
- All patients tested “on” dopaminergic medication; Sex- M:F

PROCEDURES

N-Back Task Parameters

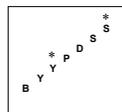
- Subjects trained on 4 conditions: 0-, 1-, 2-, and 3-back (see below)
- Letters presented one at a time on monitor; subjects made button press of “target” or “non-target” for each letter
- 30 trials divided into 12 blocks (25 trials each); 3 blocks of each of the 4 N-back conditions; Order of blocks randomized; letters randomized

0-Back



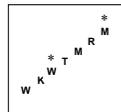
Target = letter “X”

1-Back



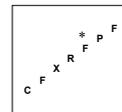
Target = letter presented 1 trial back

2-Back



Target = letter presented 2 trials back

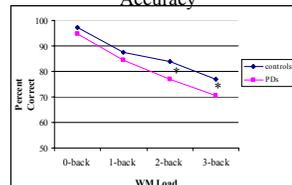
3-Back



Target = letter presented 3 trials back

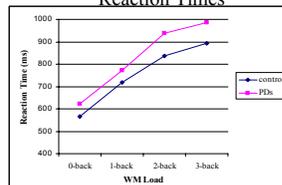
RESULTS

Accuracy



PDs significantly less accurate than Controls only on 2- and 3-back.
2 (Group) X 4 (WM load) repeated measures ANOVA:
Main Effect of Load ($p < .001$)
Interaction of Load X Group ($p < .001$)

Reaction Times



PDs tended to be slower than Controls
2 X 4 repeated measures ANOVA:
Main Effect of Load ($p < .001$)
Trend towards Main Effect of Group ($p = .08$)

RESULTS (cont.)

Does the N-back have potential clinical usefulness?

3 discriminant analyses were performed:

- 1) 2-back accuracy as only predictor variable
- 2) digit span backwards as only predictor variable
- 3) both 2-back and digit span backwards as predictor variables.

The jackknife procedure was performed to provide the most conservative and replicable estimate of classification.

Predictor Variables in Discriminant Analysis	% Subjects Correctly classified on cross-validation	Predicts group membership better than chance?
2-back accuracy	71%	yes ($\chi^2(1) = 6.66$, $p < .01$, Wilks' $\lambda = .83$)
digit span backwards	67%	no ($\chi^2(1) = 2.4$, $p = .12$, Wilks' $\lambda = .92$)
2-back accuracy + digit span backwards	60%	no ($\chi^2(2) = 3.9$, $p = .14$, Wilks' $\lambda = .86$)

CONCLUSIONS

OBJECTIVE 1:

Controls performed significantly better than PD patients in terms of accuracy on the 2- and 3-back. Interestingly, control reaction times did not significantly differ from those of PDs, although there was a trend in this direction.

• PD patients may have a reduced WM capacity and when WM capacity is pushed to the limit, deficits emerge. This notion is supported by previous studies in which impairment in WM was found in PD patients once item storage became constrained by larger set size (Lange et al., 1992; Morris et al., 1988; Owen et al., 1992, 1997)

• An alternate interpretation: PD patients are simply more vulnerable to deterioration in performance as task difficulty level increases, and impairment observed is not specific to WM processes *per se*

OBJECTIVE 2:

• Results of our discriminant analyses suggest that the n-back is only slightly more useful than digit span backwards at classifying neurologically impaired patients

• Combined with other measures, the n-back has the potential to be useful in the context of a computerized battery designed to detect impairment in “frontal lobe functioning”

• Ideally, a factor analysis should be conducted with the N-back and various other WM tests (e.g., PASAT) to determine what proportion of their variances are accounted for by the construct of working memory