Detecting Improvements with Intraindividual Variability Versus Mean Performance: A Secondary Analysis of a Compensatory Cognitive Intervention

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Background

- Dispersion intraindividual variability (IIV) may reflect more subtle multiple sclerosis (MS)-related cognitive changes than mean performance.
  - Captures variability in a person's performances across domains at a single time point, with more dispersion reflecting worse functioning [1].
- Evidence that compensatory strategy training can improve cognitive functioning in MS [2], but no studies to date have examined:
  - Whether training reduces IIV.
  - How changes in IIV compare to changes in mean performances.

Objectives

- To evaluate changes in IIV versus mean performance following a compensatory cognitive intervention.

Methods

Intervention:

- Secondary per-protocol analysis of the Telehealth Prospective Memory Intervention (TPMI) [3], with participants randomized into:
  - *Active Treatment (TPMI; n = 15):* four sessions with visualization training, then four sessions adding in implementation intentions training.
  - *Active Control (Control; n = 16):* eight sessions covering different educational topics about MS and cognition.
- All participants endorsed problems "remembering to remember," but only 22.6% had a mean memory performance score below 1 SD.

Outcome Measures:

- 11 neuropsychological tests were completed at baseline and post-treatment assessments [1], which were converted to standard scores (*M* = 100, *SD* = 15) and grouped into three domains **(Table 1)**.
  - *Mean Performance*: average score across measures in domain, with higher scores indicating better functioning.
  - *IIV:* Composite score of two metrics, with higher scores indicating less dispersion.
    - *Maximum Discrepancy Score (MDS)*: Difference between lowest and highest test score in domain.
    - *Intraindividual Standard Deviation (ISD)*: Average SD across measures in domain.
- Self-reported cognitive functioning at baseline and post-treatment was measured with the Perceived Deficits Questionnaire (PDQ).

Table 1: Neuropsychological measures used to calculate IIV and mean performances scores for each domain.

Statistical Analyses:

- Repeated measures ANOVAs used to examine changes in IIV and mean performance from baseline to post-treatment by treatment group.
  - *Covariates*: Disease duration, SymptoMScreen depression and anxiety scores, and Test of Everyday Cognition baseline performances [3].
- Partial correlations used to explore IIV and mean change scores with changes on the PDQ across all participants *(n* = 31).
  - *Covariate:* Composite SymptoMScreen depression and anxiety score [1].

Results

Change in Overall Cognition Scores:

- There was a significant effect of time on mean performance ($F(1,29) = 26.13$, $p < .001$; **Figure 1**), but no interventional effect (time x treatment).
- In the adjusted model, there was a significant interventional effect on IIV ($F(1,25) = 5.42$, $p = .028$; **Figure 2**).

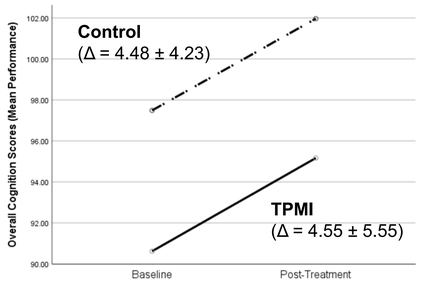


Figure 1

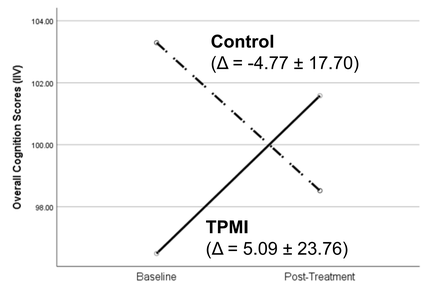


Figure 2

Change in Attention/Processing Speed Scores:

- There was a significant effect of time on mean performance ($F(1,29) = 21.95$, $p < .001$; **Figure 3**), but no interventional effect.
- There was no significant time or interventional effect on IIV (**Figure 4**).

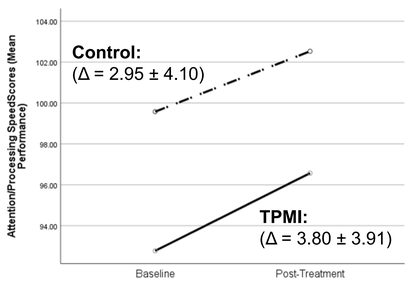


Figure 3

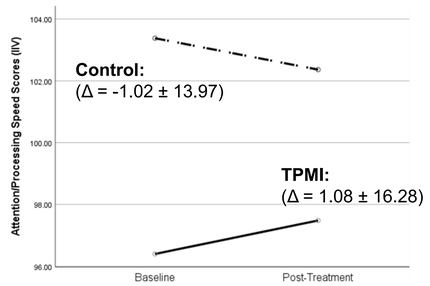


Figure 4

Change in Memory Scores:

- There was a significant effect of time on mean performance ($F(1,29) = 12.08$, $p = .002$; **Figure 5**), but no interventional effect.
- There was a significant interventional effect on IIV in both the unadjusted ($F(1,29) = 7.01$, $p = .013$) and adjusted models ($F(1,25) = 7.34$, $p = .012$; **Figure 6**).

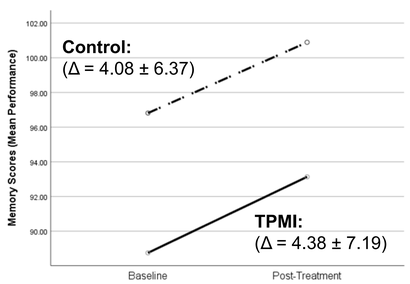


Figure 5

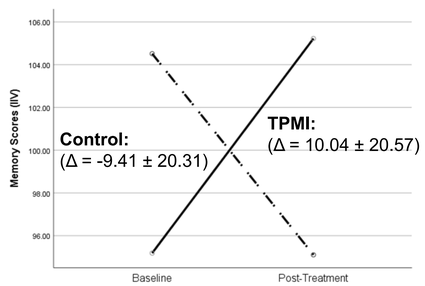


Figure 6

Results (Cont.)

Associations with Subjective Improvements:

- Perceived improvements in prospective memory (i.e., lower PDQ scores at post-treatment assessment) were associated with less overall cognitive and memory dispersion (i.e., higher IIV composite scores; **Table 2**).
  - Correlations remained significant after accounting for mood symptoms:
    - *Overall Cognition IIV:* $r = -0.38$, $p = .034$
    - *Memory IIV:* $r = -0.47$, $p = .008$
- No significant relationships with mean performance changes (**Table 2**).

Table 2: Correlations between changes in mean performance, IIV, and PDQ scores.

Conclusions

- Compensatory strategies (visualization and implementation intentions) were associated with reduced cognitive variability post-treatment, particularly on memory tests.
  - This suggests that strategy training helped participants be more consistent across tasks.
    - Visual imagery has been associated with increased brain activity and functional connectivity in other populations [4].
  - In contrast, the Control group exhibited **more** dispersion post-treatment.
  - This difference was not captured when mean performance was examined, in which both groups showed improvement over time.
- Less cognitive variability post-treatment was also associated with fewer self-reported prospective memory difficulties.
  - As individuals have fewer fluctuations in their memory, they may perceive they are having less difficulty remembering why they came into a room or if they took their medication.
- When individuals have less cognitive impairment at baseline, IIV metrics may detect more subtle improvements that may be otherwise missed.

References

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Acknowledgements

This study was funded by a pilot grant from the Consortium of MS Centers and a BestCare grant from St. Francis Hospital and Medical Center. Dr. Gromisch is a Harry Weaver Scholar of the National MS Society.

The views and opinions expressed in this article reflect those of the authors and do not necessarily reflect those of the United States Department of Veterans Affairs.