Within session practice effects on the PASAT in clients with multiple sclerosis

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Abstract

Impaired information processing speed (IPS) is common in multiple sclerosis (MS). As a measure of IPS the Paced Auditory Serial Addition Test (PASAT), the measure recommended for serial assessments by the National MS Society Task Force, is influenced by practice effects. Within session practice effects for the PASAT were examined in a sample of 30 individuals with MS. Significant practice effects on all PASAT trials were identified, with the exception of the slowest trial. Those with relapsing-remitting MS showed greater improvement on repeated assessment than those with chronic-progressive MS, on all except the slowest PASAT trial. It was concluded that, due to the extensive practice effects found at faster presentation, serial use of the PASAT in MS samples should either rely on use of slower presentations, or include some correction to account for practice effects.

Keywords: Multiple sclerosis; Practice effects; PASAT

Multiple sclerosis (MS), a degenerative disease of the central nervous system, is one of several diseases resulting in damage to the myelin covering of nerve fibers, resulting in distortion/blockage of nerve impulses (Bennett, Dittmar, & Raubach, 1991). Individual MS patients’ neuropsychological strengths and weaknesses depend in large measure on the brain region(s) impacted by the disease (Bennett et al., 1991). Despite this heterogeneity, MS frequently results in impaired information processing speed (IPS; Kail, 1998; Kujala, Portin, Revonsuo, & Ruutiainen, 1995; Moultrop & Nudelman, 1992; Paul, Beatty, Schneider, Blanco, & Hames, 1998; Rao, St. Aubin-Faubert, & Leo, 1989; Snyder, Cappelleri, Archibald, & Fisk, 2001).
The Paced Auditory Serial Addition Test (PASA T; Gronwall, 1977), an assessment of IPS, is central to assessment in MS (Kalkers et al., 2000). Indeed, an abbreviated PASA T is the only measure of cognition included in the National MS Society Task Force on Clinical Outcomes, MS Functional Composite Index (see Cutter et al., 1999; Rudick et al., 1997). Litvan et al. (1988) found that individuals with MS performed worse than controls on the two fastest PASA T trials, with no differences between chronic-progressive (CP) and relapsing-remitting (RR) forms of the disease. DeLuca, Berbier-Berger, and Johnson (1994) report poorer performance in persons with MS than in healthy controls across all PASA T trials. Diamond, DeLuca, Kim, and Kelly (1997) compared performance on the PASA T to performance on a visual analogue of the PASA T (Paced Visual Serial Learning Test; PVSA T). Individuals with MS were significantly impaired on both tasks with no disproportionate mode-specific impairment identified. Other authors have not found poor PASA T performance in MS samples (e.g., Fisk & Archibald, 2001).

The PASA T is often used to track change in functioning over time in MS. However, serial neuropsychological assessment poses a challenge as changes in performance may result from a number of factors including treatment effects, disease progression, and practice effects. McCaffrey et al. (1995) note that performance may improve due to practice effects alone, yet the literature on these effects in the absence of intervention is limited. PASA T test-retest correlations (7–10 day delay) are high (> .9; McCaffrey et al., 1995). There are, however, significant practice effects (Gronwall, 1977). For example, healthy participants administered the PASA T with a 7-week inter-test interval improved by approximately 6 points on the second assessment (Stuss, Stethem, & Poirier, 1987). Over multiple testing sessions healthy participants improve in a linear fashion, and plateau after six sessions (Feinestein, Brown, & Ron, 1994). Practice effects have also been reported in children (Dyche & Johnson, 1991), adults with brain injury (Stuss, Stethem, Hugenhotz, & Richard, 1989), and HIV (McCaffrey et al., 1995). As indicated by Stuss et al. (1987) practice effects are clinically relevant as “the improvement indicates that the first results are not likely tapping the subject’s maximum abilities on that particular test” (p. 149).

This study examined the extent of within session practice effects on the PASA T obtained by individuals with RR and CP MS.

1. Method

1.1. Participants

Thirty individuals with primary diagnosis of MS ranging from 32 to 77 years of age (mean = 53.8 years) were assessed. The sample included 12 (40%) males and 18 (60%) females, with education ranging from 9 to 17 years (mean = 12.9 years) of formal education completed. Most participants (80%) were married, while 13.3% were widowed, and 6.7% were either separated or divorced. All but one participant self-identified as being of European ancestry, while the remaining participant self-identified as being of Maori ancestry. The participant who self-identified as Maori had one parent of solely European ancestry. In regards to MS status, 12
1.2. Measures

1.2.1. Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977)

The PASAT uses a tape recorder to present the participant with an auditory list of single numbers. As presented in Spreen and Strauss (1998, p. 243–252), the participant must add each number to the preceding number and state their answer. Over four trials speed of presentation increases from a 2.4-s inter-stimulus interval (ISI), to 2.0, 1.6, and 1.2 s; with a total of 61 numbers presented in each trial. Performance on each trial is measured as the total number of correct responses produced and the amount of time per correct response.
2. Results

The results are presented in two sections. First, participants with CP and RR MS are compared in terms of demographics and test performances. Second, the overall performances participants on the PASA T and within-subject comparisons of performances over time are presented.

2.1. Comparison of MS types

An ANOVA was conducted to compare those in the sample with CP MS to those with RR MS on demographic variables (i.e., age, education, EDSS, years since diagnosis, years of symptoms prior to diagnosis). The result of this analysis was significant, $F(5, 24) = 3.505, p = .014$. Contributing to this difference were age ($p = .001$) and EDSS ($p = .002$). Age of those with RR MS ranged from 32 to 72 years with a mean age of 47.7 years, while those with CP MS ranged from 41 to 77 years with a mean age of 63.7. In regards to EDSS scores, participants with RR MS obtained scores ranging from 0 to 7.5 (mean = 2.11) while participants with CP MS obtained slightly higher scores ranging from 1 to 8 (mean = 5.2).

A second ANOVA was performed to determine whether persons with RR and CP forms of MS differed in their performances on the first administration of the PASA T (i.e., raw and standard scores). Results of this analysis were not significant ($p > .05$).

2.2. Practice effects

Mean performances across PASA T scores for those with RR and CP MS at Time 1 and Time 2 are presented in Table 1. Table 1 presents both raw scores and standard scores obtained using data from Stuss et al. (1988) as standard scores allow correction for age. In examining the mean values presented in Table 1, those with RR MS performed better than those with CP MS on the two slowest PASA T trials those with RR MS performed slightly worse than those with CP MS on the two fastest PASA T trials, but only on first administration. This later finding may indicate that those with RR MS benefit more from practice than those with CP MS on the two faster PASA T trial. Thus, while no significant between-group differences were found between MS types on initial PASA T performances, analyses of within subject change were conducted with MS type as a grouping variable due to the possibility of differential levels of change as a result of practice.

In examining change over time, Table 1 values indicate that participants’ performance improved from Time 1 to Time 2 for the three fastest PASA T trials, regardless of MS type. PASA T Trial 1 performance remained relatively stable for those with RR MS and declined slightly for those with CP MS. Statistical significance of change from Time 1 to Time 2 was assessed using within subject repeated measures comparisons with MS type as a grouping variable. Statistically, raw score performances improved significantly from Time 1 to Time 2 for 2.0-s presentation, $F(1, 28) = 15.324, p = .001$; 1.6-s presentation, $F(1, 26) = 23.029, p = .000$; and 1.2-s presentation, $F(1, 26) = 41.41, p = .000$. In addition, the interaction between improvement and MS type for the 1.2-s trial approached significance, $F(1, 26) = 4.05, p = .055$, with those with RR MS improving to a larger extent than those with CP MS. Performance on the 2.4-s presentation trial did not change significantly over time ($p > .05$).
Table 1  
Means and standard deviations of PASA T performances at Time 1 and Time 2 by multiple sclerosis type

<table>
<thead>
<tr>
<th>PASA T</th>
<th>Relapsing-remitting</th>
<th>Chronic-progressive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
</tr>
<tr>
<td>2.4-s pace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw score</td>
<td>35.67 (9.96)</td>
<td>35.33 (10.07)</td>
</tr>
<tr>
<td>Standard score</td>
<td>−.55 (0.78)</td>
<td>−.65 (0.76)</td>
</tr>
<tr>
<td>Time/correct</td>
<td>4.32 (1.09)</td>
<td>4.38 (1.18)</td>
</tr>
<tr>
<td>2.0-s pace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw score</td>
<td>26.5 (6.95)</td>
<td>31.33 (8.54)</td>
</tr>
<tr>
<td>Standard score</td>
<td>−.80 (0.73)</td>
<td>−.51 (0.80)</td>
</tr>
<tr>
<td>Time/correct</td>
<td>4.82 (1.23)</td>
<td>4.08 (1.02)</td>
</tr>
<tr>
<td>1.6-s pace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw score</td>
<td>20.5 (6.95)</td>
<td>24.17 (6.45)</td>
</tr>
<tr>
<td>Standard score</td>
<td>−.79 (0.53)</td>
<td>−.52 (0.41)</td>
</tr>
<tr>
<td>Time/correct</td>
<td>5.35 (2.24)</td>
<td>4.35 (1.52)</td>
</tr>
<tr>
<td>1.2-s pace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw score</td>
<td>13.33 (4.08)</td>
<td>17.0 (5.19)</td>
</tr>
<tr>
<td>Standard score</td>
<td>−.72 (0.40)</td>
<td>−.42 (0.35)</td>
</tr>
<tr>
<td>Time/correct</td>
<td>5.97 (2.19)</td>
<td>4.65 (1.55)</td>
</tr>
</tbody>
</table>

Though statistically significant, the changes observed must also be examined in terms of clinical significance. Though designed for those aged 14–40 years, Gronwall’s (1977) data indicates that for normal controls mean time per correct score when first assessed is 3.2 (S.D. = 0.25) with mean retest performances of 2.6 (S.D. = 0.25) on each trial. As can be seen in Table 1, time per correct response at Time 1 exceeded that of Gronwall’s controls on all trials. While retest performances also exceeded those of the controls, it is more important to note that the change at retest, which for Gronwall’s controls was 0.6 per trial, was much more variable in the MS sample. Specifically, on the slowest PASAT trial both RR MS and CP MS groups produced slower times, with performances slowing by 0.06 and 0.56 s per correct response, respectively. For the next slowest trial, practice effects were similar to those reported by Gronwall with scores improving by 0.75 and 0.33 s per correct response in RR and CP MS groups, respectively. The size of practice effects found on the two fastest PASAT trials far exceed those expected using Gronwall’s data, with improvements on the 1.6-s presentation trial of 1.0 and 1.27 s per correct response in RR and CP MS groups, respectively. Practice effects were largest on the fastest PASAT trial, with RR and CP MS groups improving by 1.32 and 2.43 s per correct response, respectively.

3. Discussion

In comparing identified PASAT practice effects to those reported in the literature, those for the present sample were similar (i.e., 1–4 point increase per trial) when compared to those
reported for adults with severe brain injury (i.e., 3–5 points per trial; Stuss et al., 1989). While these changes in raw score performances indicate similar practice effects to those reported for other neurologically impaired samples, comparisons indicate that those with MS cannot be considered similar to normal controls (i.e., Gronwall, 1977). Specifically, while normal controls are anticipated to have relatively stable practice effects across PASAT trials, the present sample showed no practice effect for the slowest PASAT trial, practice effects approximating those of normal controls on the second PASAT trial, and practice effects which more than double those for normal samples on the two fastest PASAT trials. Though replication of these findings is needed, particularly given the small sample size, that those with RR MS had greater improvement in performances than those with CP MS suggests that diagnostic types should be considered separately when determining level of change expected to result from practice alone.

It is hypothesized that the pattern of performance in this sample may be due to levels of symptomatology in the group. In discussing practice effects, Lezak (1995) notes that individuals with brain dysfunction often perform better on a second or third trial of a test. Thus, the greater the likelihood of brain impairment the more likely is improvement with repetition. As seen in Table 1 this is potentially the case for the faster presentation speeds, but is inconsistent with performance on slower trials.

An alternative is the possibility of fatigue having a greater impact on later PASAT trials. Qualitative reports from participants indicate that most experienced fatigue regardless of MS type. Thus, it is possible that including all four PASAT trials resulted in poorer performance on later trials of the first administration due to fatigue. If already experiencing fatigue at the end of the first administration, fatigue levels may not have increased to the same degree during the second administration. To test the impact of fatigue on practice effects in MS samples, repeated assessments could be conducted while varying the inter-assessment interval. Alternatively, repeated assessments of each PASAT trial could be conducted separately, thus reducing the potential impact of fatigue on the latter, faster paced trials.

3.1. Implications and conclusions

As clinically meaningful change can be obscured and inflated if correction for practice effects is not incorporated into scoring and data analysis, further research to specify the nature of PASAT practice effects is warranted. The present findings indicate that the slowest PASAT trial is least influenced by practice effects in MS samples, while the two fastest trials produce practice effects that exceed those published for normal controls. Clinically, the findings indicate that data available on PASAT practice effects in normal samples cannot be applied to individuals with MS without consideration of disease course. Further study must be conducted to replicate the above findings, preferably with larger samples, which would allow differential practice effects for RR and CP forms of MS to be examined in relation to other variables such as fatigue, and functional status. Two specific suggestions for future study are to consider experimental manipulation of fatigue effects through altering inter-assessment interval; and to conduct multiple assessments to determine the point at which practice effects no longer influence performance.
References


