Reducing Attention Deficits After Stroke Using Attention Process Training
A Randomized Controlled Trial

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Background and Purpose—Impaired attention contributes to poor stroke outcomes. Attention process training (APT) reduces attention deficits after traumatic brain injury. There was no evidence for effectiveness of APT in stroke patients. This trial evaluated effectiveness of APT in improving attention and broader outcomes in stroke survivors 6 months after stroke.

Methods—Participants in this prospective, single-blinded, randomized, clinical trial were 78 incident stroke survivors admitted over 18 months and identified via neuropsychological assessment as having attention deficit. Participants were randomly allocated to standard care plus up to 30 hours of APT or standard care alone. Both groups were impaired (z ≤ −2.0) across measures of attention at baseline, with the exception of Paced Auditory Serial Addition Test, which was below average (z ≤ −1.0). Outcome assessment occurred at 5 weeks and 6 months after randomization. The primary outcome was Integrated Visual Auditory Continuous Performance Test Full-Scale Attention Quotient.

Results—APT resulted in a significantly greater (P < 0.01) improvement on the primary outcome than standard care. Difference in change on the Cognitive Failures Questionnaire approached significance (P = 0.07). Differences on other measures of attention and broader outcomes were not significant.

Conclusion—APT is a viable and effective means of improving attention deficits after incident stroke. (Stroke. 2009;40:00-00.)

Key Words: attention ■ rehabilitation ■ neuropsychology ■ randomized clinical trial ■ stroke
vention between groups impacted reliability of the findings. Both trials\textsuperscript{17,18} also were not blinded in assessment of outcomes. A Cochrane review\textsuperscript{19} based on 2 small, controlled trials\textsuperscript{18,20} suggests that attention deficits after stroke be treated to improve alertness and sustained attention, concluding that randomized controlled trials with larger samples and blinded outcome assessment are needed. Early identification and rehabilitation of attention deficits after stroke are endorsed by the American Heart Association.\textsuperscript{21}

Most studies of poststroke attention rehabilitation examines specific attention deficits.\textsuperscript{22–24} One broad attention rehabilitation program validated in neurological samples is Attention Process Training (APT).\textsuperscript{25} APT is a theoretically based, hierarchical, multilevel treatment, including sustained, selective, alternating, and divided attention\textsuperscript{25} typically administered by neuropsychologists, occupational therapists, speech language therapists, and other rehabilitation specialists, as is appropriate within their scope of practice. APT has been examined in small, nonrandomized evaluations in TBI samples\textsuperscript{25–29,34} and is the basis of rehabilitation packages for mild deficits (APT-II)\textsuperscript{30} and for children treated with radiation after cancer.\textsuperscript{31–33} In a meta-analysis of TBI studies (total n=359) Park and Ingles\textsuperscript{34} found attention improved significantly after specific skills training in prepost studies. Several reports indicate APT also improves other cognitive areas (eg, memory) after TBI\textsuperscript{28–29} and link attention training and improved real-world outcomes,\textsuperscript{35} independent living, and return to work.\textsuperscript{24} Unfortunately, there is no robust research on APT poststroke.

This study evaluated in a large poststroke sample, APT efficacy in improving performance on tests of attention, and its impact on broader outcomes (eg, quality of life). The primary aim was to determine if, in stroke survivors identified with attention deficits, APT would improve attention at 6-months poststroke as measured by the Integrated Visual Auditory Continuous Performance Test (IVA-CPT).\textsuperscript{36} Secondary aims were to determine impact of APT on attention at 5-week follow-up (ie, postintervention); secondary aims were to determine impact of APT on disability, everyday cognition, and quality of life at 5 weeks and 6 months after stroke, as compared with standard care.

**Subjects and Method**

**Participants**

Participants were survivors of incident stroke (all pathological subtypes) admitted to 2 Auckland New Zealand hospitals over 18 months who experienced an attention deficit as determined during neuropsychological screening assessment (see Procedure). Stroke diagnosis was via standard WHO criteria.\textsuperscript{37} Individuals were excluded if they could not give informed consent; experienced severe cognitive deficits precluding participation (Mini Mental Status Exam [MMSE] <20), were medically unstable, were not fluent in English as required for standardized assessment, or had another condition that could impact results (eg, dementia). Stroke survivors were approached within 2 weeks after stroke.

**Procedure**

The study was approved by the regional ethics committee and is registered with Australian Clinical Trials Register (ACTRN12607000045415). The
of impulsive responding. Sample size was determined via power calculations, with achieved sample of 78 allowing 80% power at \( P=0.05 \) to detect a 10-point difference in change and \( >90\% \) power to detect a 15-point (1 SD) difference in change on the IVA-CPT FSAQ with 10% loss to follow-up.

Participants in the APT group received up to 30 hours of individual APT conducted for 1 hour on weekdays for 4 weeks (mean=13.5 hours, SD=9.44). Because of issues such as fatigue, a 30-hour maximum was set and hours of APT treatment received were recorded. Participants discharged from hospital before 30 hours was achieved continued to receive APT sessions in the community. All APT sessions were administered by a registered clinical neuropsychologist, who was the only member of the study team (eg, named investigators, statisticians, data management, assessors) who did not remain blind to randomization status throughout the study.

Analyses

For the primary outcome, intention-to-treat analyses were used, and the last value carried forward replaced missing 6-month values. Change in IVA-CPT FSAQ z-scores from baseline to 5 weeks and to 6 months were analyzed using mixed models. In 4 cases in which baseline data were missing (2 fatigued; 2 unable to comprehend task), mean z-score across other available attention indices was substituted. Alpha for statistical significance was \( P<0.05 \).

Results

Seventy-eight participants were randomized. Table 1 provides descriptive information for APT and standard care groups, revealing that randomization achieved good balance. Table 2 presents mean performances at baseline for the groups and significance of differences (t tests) in change from baseline between groups. Both groups were impaired across all measures was what one would anticipate if APT had a positive effect. Differences between groups in IVA-CPT FSAQ at baseline approached significance \( (P=0.064) \). Unadjusted mixed model results for the primary outcome \( (n=78) \) showed that APT group change in IVA-CPT FSAQ z-score was on average 2.03 points greater than standard care change at follow-up \( (P=0.0009) \). After adjustment for stratification factors (center, age, sex, ethnicity, Barthel) and baseline IVA-CPT, the APT group change in IVA-CPT FSAQ z-score averaged 1.61 points greater than that of the standard care group at follow-up \( (P=0.004) \). Sensitivity analyses conducted with participants missing IVA-CPT values excluded (N=68) showed that the APT groups change in IVA-CPT did not remain blind to randomization status throughout the study.

APT has a significant positive effect on attention, measured by the IVA-CPT, after incident stroke. Differences in change suggest APT was related to improvement across other measures, although not significantly so. That a significant difference between groups was not seen on other attention measures may be attributable to the ability of IVA-CPT to detect change. For example, the IVA-CPT can differentiate controls from individuals with mild TBI or adulthood attention deficit hyperactivity disorder.48 Unlike other attention tests, the IVA-CPT was not designed to merely identify attention deficits, but rather to evaluate the subtle impact of treatment regimens in children with attention deficits.49 Furthermore, the IVA-CPT full-scale attention score combines scores from visual and auditory modalities, whereas all other measures used involve only 1 modality.

Discussion

Table 1. Demographics of Participants in APT and Standard Care Groups

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>APT (N=38)</th>
<th>Standard Care (N=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean (SD)</td>
<td>70.2 (15.6)</td>
</tr>
<tr>
<td>Gender, N (%)</td>
<td></td>
<td>Male 23 (60.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 15 (39.5)</td>
</tr>
<tr>
<td>Ethnicity, N (%)</td>
<td></td>
<td>European 31 (81.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maori 2 (5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pacific Island 4 (10.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indian 1 (2.6)</td>
</tr>
<tr>
<td>Education, N (%)</td>
<td></td>
<td>Primary 2 (5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Secondary 25 (65.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polytechnic 5 (13.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University 6 (15.8)</td>
</tr>
<tr>
<td>Barthel Index</td>
<td>Mean (SD)</td>
<td>14.9 (5.3)</td>
</tr>
<tr>
<td>MMSE</td>
<td>Mean (SD)</td>
<td>26.5 (2.8)</td>
</tr>
<tr>
<td>Stroke type</td>
<td></td>
<td>Ischemic 31 (81.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intracerebral hemorrage 3 (7.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subarachnoid hemorrage 2 (5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unknown 2 (5.3)</td>
</tr>
<tr>
<td>Hemisphere of lesion</td>
<td></td>
<td>Left 14 (43.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right 15 (46.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other 3 (9.1)</td>
</tr>
<tr>
<td>Time after stroke</td>
<td>Mean (SD)</td>
<td>18.48 (11.95)</td>
</tr>
</tbody>
</table>

MMSE indicates Mini Mental Status Exam. FSAQ z-score was on average 1.96 points greater than that of the standard care group \( (P=0.002) \).
APT aims to improve attention, and improving attention has been associated with improved broader outcomes. However, in this study, significant improvement in attention as measured by IVA-CPT was not reflected in statistically significant improvement in wider outcomes, although differences across the measures trended in the direction of benefit. It is possible that the 6-month follow-up period was not long enough for changes in attention to impact these more distant measures of outcome, although there was a trend toward better overall recovery in the APT group on Medical Outcomes Study 36-item short-form questionnaire modified Rankin scale and Mental Component Score (MCS) scores. In support of this possibility, the only broader outcome measure for which differences between the groups approached significance (Cognitive Failures Questionnaire) is that which most closely maps onto underlying neuropsychological impairments in attention.

Previous studies of APT in brain-injured patients report significant improvements on the Paced Auditory Serial Addition Test, which was not found with the poststroke sample examined here. It is possible that this discrepancy is attributable to differences in the populations used (eg, stroke populations are often older than TBI populations; some were too impaired to be assessed); alternatively, it is possible that earlier findings are an example of publication bias or selective reporting. The present study was not powered to detect changes on secondary outcome measures. Detailed comparison of the current trial with other research is difficult because of the scarcity of previous trials that have predominantly focused on TBI participants, been small in size, and are frequently nonrandomized with unblinded assessment of participants.

Strengths of the study are: (1) to our knowledge it was the first full-scale randomized, controlled trial to evaluate impact of APT on attention in stroke survivors; (2) it had a relatively large sample (n=78) statistically powered to address the primary hypothesis on effectiveness of the intervention on attention, as measured by the IVA-CPT; (3) it had a very low attrition rate; and (4) the number of patients with missing data was low. The main limitations of the study were: (1) relatively strict inclusion criteria limit generalizability to wider samples; (2) although statistically powered to address...
the primary research question, sample size is too small to reliably assess other important secondary outcomes (eg, Paced Auditory Serial Addition Test, Cognitive Failures Questionnaire); (3) the number of t tests performed may have led to chance findings; and (4) because of the nature of the intervention, it was not possible to blind the treating neuropsychologist or participants and this may have influenced outcomes. Long-term sustainability of the treatment effect beyond 6 months after randomization also remains to be evaluated. Notwithstanding these limitations, APT had a highly positive effect on attention in the population studied, suggesting early intervention may be beneficial. Whether this intervention is cost-effective and leads to the improvement in other important and related area of cognition (eg, memory) and wider functional outcomes (eg, caregiver burden) should be a subject of further research.

Conclusion
In conclusion, early identification and rehabilitation of attention should be part of poststroke rehabilitation. Although the results are encouraging, further studies are required with larger samples and longer follow-up to identify characteristics of those most likely to benefit from APT and to ascertain the optimal delay before treatment. However, the positive findings for attention in this trial demonstrate that APT is a valuable intervention for patients with attention deficit after stroke.

Sources of Funding
This work was supported by the New Zealand Health Research Council (HRC Refs 06/063C and 07/070C). Dr C.M.M. Lawes is supported by a National Heart Foundation (New Zealand) Fellowship.

Disclosures
None.

References


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Stroke. published online July 23, 2009;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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