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Original article

Ready! Set? Let's Train!: Feasibility of an intensive attention training program and its beneficial effect after childhood traumatic brain injury

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ABSTRACT

Background: Attention deficits are common after pediatric Traumatic Brain Injury (TBI); they complicate return to activities of daily living and disrupt socioacademic reintegration. Yet, clinicians in rehabilitation settings have limited access to cognitive remediation protocols for which feasibility has been demonstrated.
Objective: The aim of this study was to evaluate the feasibility of intensive attention process training program Ready! Set? Let's Train! (RST), based on an adaptation of the Attention Process Training-I program.
Materials and methods: In a randomized controlled trial, participants with attention deficits were assigned to receive the attention process training intervention (RST) or Homework Assistance (HWA). Pre- and post-intervention assessments consisted of standardized attentional and executive tests and a behavior checklist.
Results: Analyses conducted for 17 participants (RST, $n = 8$; HWA, $n = 9$; mean age 14.70 ± 2.17 years, 11 males) indicated the study was successful in that it showed improvements in working memory ($F(14) = 5.44$, $P = 0.04$; $\eta^2 = 0.19$), inhibition ($F(14) = 10.18$, $P = 0.007$; $\eta^2 = 0.75$) and cognitive flexibility ($F(14) = 5.36$, $P = 0.04$; $\eta^2 = 0.57$).
Conclusions: These findings indicate positive support for combined process-specific and metacognitive strategy training for attention and executive functions.

1. Introduction

Attentional impairments are among the most pervasive consequences of pediatric Traumatic Brain Injury (TBI) with evidence of quasi-systematic deficits across selective, divided, and sustained attention [1]. Childhood TBI also affects executive functioning, which results in impairments in inhibition [2], cognitive flexibility [3], planning [4], working memory [5] and metacognition [6].

Although attentional and executive problems can persist in the long-term [7], cognitive remediation, a type of rehabilitation treatment aimed at improving cognitive functioning, appears to limit or counter the negative impact of childhood TBI [8]. For example, van't Hooft et al. [9] examined the effectiveness of an attention and memory training program (Amat-c) in children with brain injury aged 9 to 16 years and found improved sustained and selective attention in the intervention group as compared to a control group that received adult interaction and support. Similarly, Galbiati et al. [10] examined the impact of a computerized attention remediation program (RehaCom) in children 6 to 18 years with TBI (45 min, 4 times a week for 6 months) and found greater improvement in inhibition, sustained and selective attention in the intervention group than children who did not complete the program. One of the limitations of these intervention programs is that they were designed to last between 17 and 40 weeks. Although these lengthy programs may be efficient in the context of severe brain injuries, they have limited feasibility and are often unrealistic in clinical settings, where services need to be economical and efficient.

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The Attention Process Training-I (APT-I) program appears to have considerable utility in addressing attentional deficits after TBI. Based on Sohlberg and Mateer's [11] theoretical model, the APT-I includes visual and auditory exercises targeting 5 attentional components (focalized, sustained, selective, alternating, divided). Positive results for attention have been documented in adults with TBI, as well as transfer effects to memory and activities of daily living [12], which suggests extensive beneficial effects of the program. An adaptation of the APT (Pay Attention!) [13], designed for children 4 to 10 years old, showed improvements for sustained, selective and alternating attention in children with attentional deficits related to fetal alcohol syndrome [14] and in fluid reasoning, cognitive flexibility and working memory in children with Attention-Deficit/Hyperactivity Disorder (ADHD) [15]. However, currently available APT training methods have no predefined program structure and are typically designed to last between 17 and 40 weeks. These characteristics imply time-consuming planning by clinicians for each session and the overall program. In addition, no APT program exists for individuals between age 10 and 17 years. A further constraint of previous work is that most cognitive rehabilitation approaches tend to be based on attention-specific approaches, omitting metacognitive strategies.

To address these limitations, we developed the Ready! Set? Let's Train! (RST) program [16], an adaptation of the APT-I [17], for youth between age 10 and 17 years, with specific inclusion of a metacognition component. The RST program [16] is based on Sohlberg and Mateer's [17] model but has a predefined, structured program, which involves training each attentional process by using a specific number of tasks within the same session. To improve understanding of the bases of each attentional exercise and to increase motivation for the training program, lay descriptions of each attention component are included in the protocol. To improve awareness of attentional difficulties and control over cognitive and behavioral functioning, feedback and self-evaluation of performances are reviewed with the participant after each task in order to develop effective metacognition. Developmental research suggests a link between the self-regulation aspect of metacognition (e.g., monitoring and control) and the development of executive functions [18]. Limited attention has been paid to the evolution of metacognition during adolescence. However, in one study, adolescents (aged 13–15 years) and adults evaluated their performance on propositional, spatial and social reasoning tasks, and self-evaluation was shown to improve between adolescence and adulthood [19].

Metacognition includes 3 theoretical components: knowledge, experience and metacognitive strategies [20]. The development of metacognitive strategies, such as slowing down responses to preserve a high level of accuracy, enhances executive functions such as inhibition [21]. For example, knowing how to slow down is particularly important for facilitating inhibition, whereas detecting errors and considering alternative responses is thought to be important for emphasizing shifting [22]. In the RST program, the 3 metacognitive components (knowledge, experience and metacognitive strategies) are reunited to allow for optimal control over attentional processes and other cognitive processes such as memory and executive functions.

Demonstrating feasibility of an intensive attention remediation program that includes metacognition has obvious benefits for prognosis after pediatric TBI and may also facilitate clinical work in rehabilitation settings. According to Sohlberg et al. [12], attention process training refers to a deliberate effort to administer a therapeutic program that improves a wide range of tasks involving attention. Thus, the aim of this study was to evaluate whether an intensive structured attention process-training program, the RST [16], is feasible in a clinical setting and is more effective than Homework Assistance (HWA). We expected improvements in (1) attentional functioning, such as in vigilance, sustained, selective, alternating and/or divided attention; and (2) generalization to memory (verbal/auditory) and executive functioning (working memory, inhibition, goal planning and/or flexibility) because attentional functions are implicated in these processes.

2. Material and methods

2.1. Participants and setting

We used an exploratory approach because of sample size restrictions. The study was approved by the local ethics committee and all participants provided written consent for participation. We recruited children and adolescents with TBI who were consecutively admitted to a Quebec rehabilitation center between June 2012 and September 2013. Inclusion criteria were:

1) age 10.0 to 17.0 years;
2) documented evidence of TBI sufficiently detailed to determine injury severity;
3) chronic phase (time since injury between 3 months and 6.0 years);
4) IQ $\geq$ 80;
5) French-speaking;
6) attending an academic institution;
7) complaints of new or increased attentional deficits since the TBI, by the participant or the parent during the medical history performed by a neuropsychologist.

Exclusion criteria were (1) evidence of pre-existing physical, neurological, psychiatric or developmental disorder other than ADHD and (2) medication known to affect cognitive functioning, other than psychostimulants. ADHD presence was not excluded mainly because it represents an important proportion of the pediatric TBI population [23]. Thus, its exclusion would have biased the sample and limited the recruitment.

Children were divided into intervention and control groups by simple randomization or covariate-adaptive randomization because recruitment was conducted in 2 phases (see Figs. 1 and 2). The intervention group received the attention-training program RST [16] and the control group received HWA. We used an active control group to control for the effects of fixed and constant sessions with the presence of a therapist, a factor known to create placebo type improvements [24] and to control for test-retest effects.

2.2. Procedure

Before and after the intervention, participants were assessed on a cognitive battery including attentional, and executive measures (see Fig. 1). No repeated baseline measures were performed before the intervention. The mean delay between the pre-intervention assessments and the intervention was 99 and 35 days for the RST and HWA groups and mean delay between the end of the intervention and post-intervention assessments was 3 and 9 days, respectively. The assessment was divided into 2 (ages 12–17 years) or 3 sessions (ages 10–11 years) with breaks as needed. The order of the tests was counterbalanced between participants and pre- and post-assessment. The blind post-intervention assessments were performed by 3 graduate students who received formal psychometric training.

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