Computer-Based Cognitive Intervention Improves Memory and Attention in Adolescents with Fontan Completion

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Introduction

- Adolescents with single ventricle heart disease (SVHD) who have undergone Fontan completion often present with mild to moderate cognitive deficits, in particular working memory and attention.
- However, it is unknown whether working memory and attention / concentration, as well as brain tissue integrity can be improved with a cognition intervention.

Purpose

Examine the impact of the Cogmed Working Memory Training in adolescents with Fontan completion on working memory and attention / concentration and brain tissue integrity.

Methods

- **Design**: Pre- & Post-Intervention, Pilot Study
- **Subjects**: 14-18 years of age with SVHD who have underwent Fontan completion were recruited from cardiology clinics and a camp in Southern California.
- Intervention: Cogmed [®](home, computer-based working memory training program with Zoom coaches), 45-minute sessions, 5 day a week, for a total of 5 weeks [total 25 sessions].
- **Measures**: Wide Range Assessment of Memory and Learning 2; Working Memory Index (WMI), Attention / Concentration Index (ACI), and General Memory Index (GMI)]. Brain tissue integrity assessed by 3.0-Tesla brain MRI using DTI-based mean diffusivity (MD) measures.
- **Analysis**: All measures were assessed at baseline and post intervention using one-sample, 2 tailed ttest for cognitive scores, and MD values via paired t-test (SPM12 software; covariate, age; p<0.005).

- improvement post-intervention [Table 2].
- tissue improvement [Figure 1]

Table 1. Subject Characteristics

Table 1. Subject Characteristics		Table 2. Cognitive Scores Pre & Post-Intervention			
Variables	Mean [SD] or n (%) N=5	Cognitive Scores	Pre N=5	Post N=5	P-Value
Age [years]	16.6 [1.1]		Mean [SD]		
Gender [Male]	3 [60%]	Working Memory Index*	88	110	<0.001
Ethnicity [White]	5 [100%]	Attention/Concentration Index*	80	97	0.001
BMI [kg/m2]	20.4 [4.9]	General Memory Index*	79	106	<0.001
Ventricle Type [Right]	3 [60%]				
Fontan [Extracardiac]	5 [100%]	*Wide Range Assessment of Memory and Learning 2			
Oxygen Saturation [mean]	92%				



Results

Five adolescents [3 males, age 16.6 ± 1.1 years, BMI 20.4 ±4.9 kg/m2] with extracardiac Fontan completion, 3 single right ventricle, mean oxygen saturation level 92% [Table 1] completed all 25 sessions in 5 weeks. Postintervention assessments were performed between 3-8 weeks. Cognitive scores showed significant

Decreased MD values appeared in the right cerebellum (10⁻³ mm²/s; 0.67±0.03 vs 0.68±0.03), caudate (10⁻³ mm^{2}/s ; 1.02±0.13 vs 1.04±0.11), putamen (10⁻³ mm²/s; 0.60±0.34 vs 0.61±0.34), thalamus (10⁻³ mm²/s; 0.73±0.08 vs 0.74±0.07), frontal white matter (10⁻³ mm²/s; 0.70±0.04 vs 0.72±0.03) and left frontal cortex (10⁻³ mm²/s; 1.36±0.28 vs 1.40±0.27), post vs. pre-intervention respectively, indicating post-intervention brain

Figure 1. Brain Regions with Decreased MD Values

Brain regions showed **decreased MD values** in the right putamen (a), thalamus (b), frontal cortex (c) and white matter (d), cerebellum (e), and caudate (f) in post-intervention over preintervention SVHD subjects.

All images are in neurological convention (L = left; R = right). Color bar indicates t-statistic values.

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Conclusions

• Cogmed[®] intervention showed improvement in general memory, working memory and attention / concentration in adolescents who have undergone Fontan completion.

• Improved brain tissue injury in regions that support working memory / attention indicate potential post-intervention improvement.

• Further studies are needed in a larger cohort and to assess the long-term intervention benefit.

Clinical Implications

• Executive function is a set of mental skills that includes working memory, flexible thinking and self-control. We use these skills every day to plan, focus, remember instructions and juggle multiple tasks in our everyday life.

• This intervention could **potentially improve** academic performance and self-management skills with transition to adulthood.

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