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Cognitive skills training for homeless transition-age youth: feasibility and pilot efficacy of a community based randomized controlled trial

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Abstract

Cognitive impairments are common in homeless youth, and negatively impact academic and vocational outcomes. We examined the feasibility and efficacy of cognitive interventions provided to 18–22 year-old homeless youth living in urban supportive housing. Ninety-one homeless youth were randomized to receive either targeted cognitive training (cognitive remediation) or general cognitive activation (computer skills training). Cognitive and psychological outcomes were assessed at baseline, after 13 and 26 sessions, and one month post-intervention. A high drop-out rate highlighted the feasibility challenges of treating this population. Intent-to-treat analysis found significant improvements across groups in specific and global measures of cognition and psychological distress, with no significant group differences. Transition-age homeless youth show improvements in cognitive and psychological functioning when engaged in interventions that address their cognitive development. This speaks to the malleability of cognitive skills in this cohort and lays the groundwork for future research to address their cognitive health.

Keywords

Homeless; Transition-age; Cognition; Cognitive Health

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Introduction

Homeless youth are a numerous and growing population in the United States, with yearly estimates of about 2.5 million individuals under the age of 21, representing at least one-third of the total homeless population in the course of each year (Bassuk et al., 2014; Covenant House Institute, 2009; Toro et al., 2007). Homeless youth are a vulnerable population, as they are likely to experience significant disadvantage during critical developmental periods, resulting in elevated risk for concurrent emotional and behavioral problems, and poorer prospective community functioning. Indeed, childhood adversity, including residential instability, is one identified risk factor for homelessness in adulthood, and longer duration of homelessness is associated with poorer functional outcomes (Bradley and Corwyn, 2002; Edidin et al., 2012; Ensign, 1998; McCaskill et al., 1998; Whitbeck and Hoyt, 1998; Whitbeck et al., 2004; Zima et al., 1994). It is widely acknowledged that comprehensive services tailored to meet the specific needs of homeless youth are imperative, in order to break the cycle of adversity (Edidin et al., 2012).

Cognitive health is an understudied target of services for homeless youth, particularly since homeless youth evidence significant neurocognitive impairment and decremented educational and vocational achievements relative to age matched peers (Backer and Howard, 2007; Farah et al., 2006; Fry et al., 2016; Noble et al., 2005; Obradovic et al., 2009; Parks et al., 2007; Rescorla et al., 1991; Rubin et al., 1996; Whitman et al., 1990). Neurocognition describes processes, such as memory, attention, planning, and problem-solving, all of which are necessary to carry out fundamental activities of daily living and provide a platform for learning new skills. Multiple pre-existing and ongoing factors intertwine to negatively impact cognition in this population: learning disabilities, lack of support for, or chances to engage in learning opportunities, chronic stressors and traumas, psychopathology, nutrition, health disparities, and inadequate treatment are some of the factors identified as negatively impacting cognition (Farah et al., 2006; Fry et al., 2016; Hackman et al., 2010). Attention to cognitive health is often neglected in light of the provision of more basic service needs (i.e., residential placement, medical care) and/or mental health treatment. Yet, impaired neurocognition can limit participation in and potential benefit from available mental health services, educational and job training programs, thereby impacting the ability to achieve educational goals, gainful employment and sustain independent housing (Ammerman et al., 2004; Bell and Bryson, 2001; Depp et al., 2015; Green, 1996; McGurk and Mueser, 2004; Schutt et al., 2007). Ideally, service agencies would address the numerous factors etiologically central to cognitive development, as well as provide tools to improve cognitive skills.

Within the 18–22 year-old transition-age subgroup of homeless youth, the negative impact of intertwining mental and cognitive health problems is strikingly evident. In prior research (Saperstein et al., 2014), 83.6% of a transition-age homeless sample met criteria for a DSM-IV Axis I disorder, the most prevalent of which were anxiety, substance use, and mood disorders. Half of these Axis I diagnosed youth scored below 70% of the age-matched normative population on measures of cognition, with the most prominent deficits in the domains of verbal and working memory. Further, cognitive impairment was found to be

associated with a significant risk for making a wage insufficient for independent living, even in the context of receiving vocational services (Saperstein et al., 2014).

Interventions that target neurocognition have the potential to promote skill acquisition, thereby helping homeless youth build a foundation for positive growth. This is critical for older youth with psychiatric diagnoses, as they have been shown to have cognitive vulnerability and are on the cusp of adulthood, preparing to cull their resources and skills to function independently as adults in the community. Cognitive remediation interventions have been utilized in a range of populations including homeless adults (Cotman and Sandman, 1997; Medalia et al., 2003) and yielded positive outcomes with respect to improving neurocognitive and community functioning (Bowie et al., 2012; Cicerone et al., 2005; Cotman and Sandman, 1997; Medalia et al., 2003; Medalia and Saperstein, 2013; Mintz et al., 1992). To date, no controlled studies have been conducted to determine the possible benefits of cognitive intervention in homeless youth. This study aimed to address the service gap in the use of integrated psychosocial interventions for homeless populations.

The study was designed to determine the feasibility of implementing a cognitive health intervention for homeless transition-age youth with psychiatric diagnoses, and the relative efficacy of targeted training in neurocognition provided by cognitive remediation as compared to general cognitive stimulation. All subjects were enrolled in psycho-social programs in their supportive housing agency. The cognitive remediation approach used is based on NEAR, a manualized intervention that has been used internationally with homeless adults, youth with psychotic and affective disorders, and is currently disseminated in New York State Office of Mental Health outpatient clinics (Medalia et al., 2015; Medalia et al., 2009). All forms of cognitive remediation require specific agency conditions and staff training which may be unnecessary if youth are as responsive to the general cognitive stimulation inherent in computer skills training that might additionally boost their employability. By controlling for the staff and computer time and exposure, session intensity and duration across conditions, we examined the feasibility and comparative efficacy of these two approaches to enhancing cognition and psychological outcomes.

Methods

Participants and Procedures

Participants in this IRB approved, registered clinical trial (NCT01815398) were 18–22 year-old residents enrolled in vocational and educational support programs at Covenant House (CH), a transitional living center for homeless youth in New York City. The New York State Psychiatric Institute IRB provided oversight for the protection of human subjects. Study inclusion criteria were English speaking, in support programs at CH at least 1 month, a current DSM-IV-TR (American Psychiatric Association, 2000) Axis I diagnosis, psychiatrically stable for 21 days on any prescribed psychotropic regimen. Exclusion criteria were Full Scale IQ less than 70 as determined by testing or history of Mental Deficiency, unremitted substance dependence in the past 6 weeks, active risk of suicide or violence. Between November 2012 and October 2015, a total of 188 residents signed written informed consent to participate and were screened for eligibility using the Structured Clinical Interview for DSM-IV-TR (SCID-I) (First et al., 2002), an assessment of major mental

health diagnosis, and Wechsler Test of Adult Reading (WTAR) (Wechsler, 2001), a measure which estimates intellectual functioning. The screening interview was conducted by a Master's-level research assistant or author AS, who participated in the Institute's SCID-I training and reliability sessions. The majority of those ineligible (N = 68) were excluded based on lack of psychiatric diagnosis (69.2%).

A sample size of N = 100 was calculated from a power analysis based on longitudinal models, assuming a 2-group design, a random effects structure, moderate effect sizes for primary cognitive outcomes, and three time-points with a 10% attrition rate between each pair of assessments. Of the 188 screened, 105 youth met initial eligibility criteria and were randomized to a treatment condition via predetermined sequential numbering generated by Excel. The randomization sequences were unconcealed only to author AS, who was responsible for group assignment. Subjects became aware of their group assignment after baseline assessment at their first session, and remained blinded as to the "active" or "control" nature of the skills training interventions. Due to the intervention contents, the study therapist was not blinded to group assignment. All procedures took place at CH to facilitate integration with routine psycho-social support programs which included vocational and educational services.

A total of 91 completed a baseline neurocognitive and psychological assessment administered by a trained research assistant, who was blind to group assignment. The assessment schedule in this feasibility study was originally set at baseline, at the end of the 26 sessions, and one month later. After an interim feasibility analysis found the attrition rate between baseline assessment and post-treatment assessment (75.8%) was significantly greater than initially expected, the study schedule was modified to include a mid-point assessment after 13 sessions. Thus 18 months into the study, the assessment schedule changed to baseline, after 13 sessions (mid-point) and after 26 sessions (post-treatment). The consort diagram (Figure 1) provides enrollment, randomization and completion statistics.

Subjects were randomized to receive either targeted cognitive training (TCT) or general cognitive activation (GCA). Both conditions involved working on computer exercises, but only TCT involved actual training in cognitive skills like attention, memory or processing speed, while the GCA condition involved learning how to use Microsoft Office. Treatment in both conditions consisted of 26 manualized, twice weekly sessions; each training session was 70 minutes. The TCT condition followed a rubric of therapist-guided computerized learning activities focused on the practice of cognitive skills (e.g. memory, processing speed, reasoning/problem solving) and included a bridging discussion (Medalia et al., 2009) of those cognitive skills and strategy use to aid cognitive functioning within the context of work and independent living skills. The computerized cognitive training activities targeted specific cognitive skills but were distinctly different from the cognitive outcome measures. In contrast, GCA employed an online program and therapist-guided practice for learning Microsoft Office (e.g. Word, Excel, PowerPoint). The same therapist offered assistance in setting up computerized training exercises and coaching during learning activities in both conditions. Subjects continued to work and participate in CH programming while participating in the study. Treatment fidelity was monitored weekly by author AS to determine compliance with (1) treatment structure and session organization, (2) group

composition, (3) clinician competence, (4) computer learning activities, (5) bridging discussion content and format, (6) learning context.

Instruments/Outcomes

Neurocognitive Assessment—The neurocognitive tests measured the cognitive domains of verbal memory, working memory, attention, processing speed, and executive functioning. Tests comprising each cognitive domain score are as follows.

Verbal Memory: Wechsler Memory Scale–IV (WMS-IV) Logical Memory I and Logical Memory II Total Scores (Wechsler, 2009), California Verbal Learning Test-II (CVLT-II) Immediate Free Recall Total and Long Delay Free Recall Total (Delis et al., 2000).

Working Memory: Wechsler Adult Intelligence Scale–IV (WAIS-IV) Digit Span Subtest and Arithmetic Subtest Total Scores (Wechsler, 2008).

Attention: Delis Kaplan Executive Function System (D-KEFS) Trail Making Visual Scanning, Trail Making Number Sequencing, and Making Letter Sequencing Scores (Delis et al., 2001).

Processing Speed: WAIS-IV Symbol Coding and Symbol Search Subtest Scores (Wechsler, 2008).

Executive Functioning: D-KEFS Trail Making Letter Number Switching Score, D-KEFS Verbal Fluency - Letter Fluency Score, D-KEFS Tower Test Score (Delis et al., 2001).

Raw scores on each performance measure were translated into Z scores based on published test norms. Z scores were averaged together within each cognitive domain to yield 5 domain scores. A Global Cognition Score was derived from the average of the domain Z scores. Supplemental composite scores based on published test norms included the Working Memory Index and Processing Speed Index (Wechsler, 2008). Neuropsychological performance validity was assessed with behavioral observations of effort, analysis of response patterns, and indices from conventional embedded measures (e.g. Reliable Digit Span, Recognition Memory).

Psychological Assessment—Mental health symptoms measures included the Beck Depression Inventory–II (BDI-II) (Beck et al., 1996), Beck Anxiety Inventory (BAI) (Beck and Steer, 1990), and the Symptom Checklist-90-R (SCL-90-R) (Derogatis, 1994). BDI-II and BAI are reported as total scores; SCL-90-R scores on the Global Severity Index (GSI), Positive Symptoms Distress Index (PSDI), and Positive Symptom Total (PST) are reported as T scores.

Statistical Analysis

All analyses were carried out in SAS 9.4 software after verifying that data were normally distributed. An intent-to-treat analysis of study completion and cognitive outcomes was conducted using all randomized participants who attended at least 1 treatment session. Randomization visit differences between treatment groups or between those who dropped

out and study completers were assessed using 2-sample t-tests for continuous variables and χ^2 tests for categorical variables. Linear mixed effect regression models tested post-randomization group differences in the cognitive and mental health symptoms measures from baseline to mid-point or post-intervention. Within group changes were tested using paired t-tests and Cohen's d for change scores in outcome variables. To determine the magnitude of change for those who improved on cognitive measures, and whether changes exceeded practice effects, the reliable change index (RCI) (Jacobson and Truax, 1991) and the 95% confidence interval were computed and compared to those based on test-retest data for healthy individuals provided in the test manuals. The number of participants whose improvement exceeded 1.96 standard deviations of the test-retest data is reported.

Results

Subject Characteristics

There were 91 participants in the randomized treatment phase (TCT N = 43; GCA N = 48) of whom 56% were female, 71.43% self-identified as Black/African American, 20.88% as Hispanic or Latino, 1.1% as Caucasian, and 6.59% as "other race or ethnicity". Average age was 20.14 (SD = 1.03). Years of education ranged from 8 to 14; 47.25% of participants had a high school diploma, 15.38% obtained a GED, 2.2% had an Associate's degree and the remainder (35.16%) had not completed any formal schooling. The mean WTAR demographics-predicted Full Scale IQ (WTAR FSIQ), was 83.78 (SD = 6.71), with a range between 73 (lowest) and 102 (highest). See Table 1 for the group specific demographics. The mental health diagnoses of participants were as follows: Mood Disorders (e.g. dysthymia, major depressive disorder, bipolar disorder) 26.37%, ADHD 20.88%, Anxiety Disorders (e.g. post-traumatic stress disorder, generalized anxiety disorder) 19.78%, Substance Abuse Disorders 18.68%, Adjustment Disorders 14.29%.

There were no significant differences in the demographic characteristics (age, ethnicity, gender, education, IQ, employment, diagnosis) or baseline cognitive measures between the two treatment groups at time of randomization, or between those who dropped out before completing any second assessment (N=45) and those who completed a second assessment (N=46). Furthermore, there was no significant difference in demographic variables between those who dropped out prior to baseline (n=14) and those who completed the baseline assessment (N=91).

Feasibility Measures

Lost to follow up (LTF) was the primary feasibility measure in this highly transient population. LTF increased proportionally with the time period: during the shortest period from randomization to baseline assessment, the LTF was 13%. LTF increased to 50% from baseline assessment to 13 sessions, was 76% by 26 sessions and 87% by the one-month post 26 session assessment. LTF did not differ significantly between the two conditions. The majority of subjects were lost to follow up because they moved, were discharged from services, had scheduling conflicts or were withdrawn for behavioral instability (fighting and other disruptive behaviors). Time to complete 13 and 26 sessions was the secondary feasibility measure. Subjects were scheduled to attend twice weekly sessions, but took on

average 12.7 and 24.6 weeks to complete 13 and 26 sessions respectively. Time to complete did not differ significantly between the two conditions.

Cognitive Outcomes

Assessment of effort indicated all cognitive test scores were representative and valid. We hypothesized that the targeted cognitive training (TCT) group would show greater benefit on measures of cognition, compared to the general cognitive activation (GCA) group. Within-group paired t-test analysis of mean change from baseline (Table 2) showed that the TCT group (N = 43) made significant gains in executive functioning ($\text{mid-baseline} = 0.83$, 95% CI 0.40 to 1.26; $d = 1.23$; $p = 0.001$), processing speed ($\text{mid-baseline} = 0.42$; 95% CI 0.19 to 0.65; $d = 1.16$; $p = 0.002$), and global cognition ($\text{mid-baseline} = 0.41$; 95% CI 0.28 to 0.53; $d = 2.11$; $p < 0.0001$) from baseline to mid-point and in verbal memory ($\text{post-baseline} = 0.36$; 95% CI 0.05 to 0.68; $d = 0.82$; $p = 0.029$) from baseline to post-treatment. The GCA group (N = 48) made significant gains in executive functioning ($\text{mid-baseline} = 0.49$, 95% CI 0.22 to 0.77; $d = .90$; $p = 0.001$), verbal memory ($\text{mid-baseline} = 0.74$, 95% CI 0.47 to 1.02; $d = 1.33$; $p < 0.0001$), and global cognition ($\text{mid-baseline} = 0.31$, 95% CI 0.19 to 0.43; $d = 1.26$; $p < 0.0001$) from baseline to mid-point and from baseline to post-treatment: executive functioning ($\text{post-baseline} = 0.55$, 95% CI 0.03 to 1.07; $d = .67$; $p = 0.04$); verbal memory ($\text{post-baseline} = 0.89$, 95% CI .27 to 1.52; $d = .91$; $p = 0.009$), and global cognition ($\text{post-baseline} = 0.33$, 95% CI 0.06 to .59; $d = .77$; $p = 0.02$). After Bonferroni correction (66 comparisons), only baseline to mid-point change in global cognition survived in the TCT group. In the GCA group, only baseline to mid-point change in verbal memory and global cognition survived after Bonferroni correction. Neither group demonstrated significant differences in the cognitive gains made at session 13 versus 26 except in the area of processing speed ($p = 0.043$). This did not survive after Bonferroni correction.

The intent-to-treat analysis (N = 91) found a significant effect of time on verbal memory ($F(2,89) = 20.28$; $p < 0.0001$), processing speed ($F(2,89) = 9.35$; $p = 0.0002$), executive functioning ($F(2,89) = 22.26$; $p < 0.0001$), attention ($F(2,89) = 3.67$; $p = 0.03$), and global cognition ($F(2,89) = 39.89$; $p < 0.0001$). The interaction between time and treatment group was not significant and thus did not support the hypothesis that the TCT group would make greater cognitive gains relative to the GCA group. Both groups benefitted from the interventions across cognitive domains. Results are summarized in Table 2. Treatment gains in verbal memory ($\beta = 0.58$, 95% CI 0.31–0.86; $t(1,89) = 4.21$; $p < 0.0001$), processing speed ($\beta = 0.24$; 95% CI 0.04–0.44; $t(1,89) = 2.33$; $p = 0.02$), executive functioning ($\beta = 0.51$; 0.28–0.75; $t(1,89) = 4.27$; $p < 0.0001$), and global cognition ($\beta = 0.29$; 95% CI 0.19–0.39; $t(1,89) = 5.68$; $p < 0.0001$) were evident at 13 sessions.

Magnitude of Cognitive Improvement

After 13 sessions most participants (>50%) improved in the domains of verbal memory, executive functioning, working memory, and processing speed. Across cognitive tests, the percent of improvers with a RCI score indicative of improvement significantly greater than that expected by chance or practice effect ranged from 0 to 60% (Table 3), with the largest magnitude of improvement seen in the area of executive functioning.

Impact on Psychological Outcomes

The intent-to-treat analysis ($N = 91$) found a significant effect of time on the SCL-90-R Global Severity Index (GSI), a measure of overall psychological distress, which declined ($F(2,89) = 11.21$; $p < .00001$). There was a significant group by time interaction on the GSI ($F(2,89) = 16.60$; $p < .00001$) accounted for by group differences at mid-point which disappeared at post-treatment. There were no significant associations between changes in GSI and cognition (p values > 0.14).

Discussion

Support services for transition-age homeless youth focus on mental and physical health, and obtaining employment to facilitate independent living. To optimally address the needs of this population and facilitate a trajectory of employment and stable housing, attention must also be paid to the cognitive factors that may impede academic or vocational goal attainment. This study examined the feasibility and efficacy of providing interventions to address cognitive functioning in homeless transition-age youth with any major mental health diagnosis.

Feasibility analysis focused on percent of randomized youth who completed the baseline assessment, 13 and 26 sessions, or the one-month follow up. Completion rates were quite low; indeed because so many youth (76%) were lost to follow up by treatment endpoint (26 sessions), the study methods were modified to capture the more realistic goal of completing 13 sessions. Even so, only half of randomized subjects completed both an assessment and 13 sessions of treatment. Reasons for study discontinuation reflected the challenges homeless youth face participating consistently in any program. They moved, were discharged from services, had scheduling conflicts, or were withdrawn for behavioral instability. As high as these rates are, they are typical for homeless populations (Council on Community Pediatrics, 2013) and are a sobering reminder of the challenges in offering services to this needy population.

Efforts to enhance consistent attendance and retention included phone calls and text message appointment reminders, coordination with CH resident advisors, and pairing treatment sessions with concurrent employment and life skills workshops. To offset any undue burden for those with simultaneous work and/or school commitments, reimbursement for public transportation costs to attend study sessions and flexible session times, including evening hours, were offered. Yet those who completed treatment sessions through mid- or end-point rarely attended both scheduled sessions in a week, and instead averaged once per week. Thus once weekly sessions were more feasible to implement in this service setting.

This study also sought to gather pilot efficacy data on two types of cognitive interventions. We hypothesized that cognitive and psychological outcomes of youth randomized to cognitive remediation, a targeted cognitive training intervention considered efficacious for people with psychiatric illnesses, would be better than those of youth in the intervention that provided general cognitive activation. Results of the efficacy analysis did not support this hypothesis. The group receiving cognitive remediation, which provides specific exercises in

attention, processing speed, working memory, memory and executive functioning made significant improvements in cognitive skills. However this was also true of the group that learned to use the Microsoft Office suite of applications, a training that required general cognitive activation. Both groups involved therapist-led sessions, held with the same frequency and duration. Consideration of the magnitude of cognitive improvement for the total sample found the majority of participants improved in the domains of verbal memory, executive functioning, working memory, and processing speed, and up to 60% of improvers evidenced gains greater than that expected by chance or practice effect. Thus providing a cognitive intervention is beneficial for cognitive functioning, but there is not support for the use of a targeted over a general activation approach. The significant improvement in cognition evident after 13 sessions, and lack of difference in cognitive gains between those who finished 13 and 26 sessions, suggests that a course of 13 seventy minute sessions is sufficient to promote cognitive improvement. A briefer treatment is desirable, because of the feasibility issues inherent in providing services to this transient population.

A secondary aim was to assess changes in psychological functioning and their relationship to cognitive changes. In this study, the significant decrease in overall level of emotional distress that both groups evidenced was not significantly associated with cognitive change, suggesting the independence of cognitive and emotional functioning in this sample. Attribution of the decreased emotional distress to the non-specific therapeutic factors of the intervention is possible.

This study has limitations, several which relate to the challenges in working with this unstable, transient population. The high attrition rate, and small sample completing the intervention limit the power to detect group differences. Another limitation is the generalizability of findings. This was a help-seeking population of homeless transition-age youth with psychiatric illnesses, who had successfully transitioned from a state of crisis to a stable state in which enrollment in a psychosocial support program was warranted. Also, we report here on a sample from only one urban community-based organization. These factors may limit the applicability of our findings to homeless transition-age youth more broadly.

Conclusion

Interventions that address cognitive skills in homeless transition-age youth have the potential to improve both cognitive and mental health outcomes. This study showed that a briefer thirteen session intervention was more feasible and as effective as a longer twenty-six session program, and that structured general cognitive activation is as effective as a specific cognitive remediation program at improving verbal memory, processing speed, executive functioning, attention, and global cognition. The cognitive gains on neuropsychological testing exceeded those expected by practice effects, suggesting the neuroplastic capacity, and responsiveness to learning opportunities, in this transition-age population. Future studies are needed to better understand the mechanism of therapeutic change, and to explore treatment approaches that enhance feasibility of participation.

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Figure 1.

Table 1**Baseline Demographics and Functioning**

Variables	TCT (n = 43) n (%)	GCA (n = 48) n (%)	Total (n = 91)
Gender			
Male	20 (46.51)	20 (41.67)	40 (43.96)
Female	23 (53.49)	28 (58.33)	51 (56.04)
Ethnicity			
Caucasian	0	1 (2.08)	1 (1.10)
Black/African American	29 (67.44)	36 (75)	65 (71.43)
Hispanic/Latino	9 (20.93)	10 (20.83)	19 (20.88)
Other	5 (11.63)	1 (2.08)	6 (6.59)
Baseline Employment			
No	15 (34.88)	14 (29.17)	29 (31.87)
Yes	28 (65.12)	34 (70.83)	62 (68.13)
Diagnosis			
Adjustment	7 (16.28)	6 (12.5)	13 (14.29)
ADHD	9 (20.93)	10 (20.83)	19 (20.88)
Anxiety	8 (18.60)	10 (20.83)	18 (19.78)
Mood	10 (23.26)	14 (29.17)	24 (26.37)
Substance Abuse	9 (20.93)	8 (16.67)	17 (18.68)
Baseline Educational Degree			
HS Diploma	20 (46.51)	23 (47.92)	43 (47.25)
GED	7 (16.28)	7 (14.58)	14 (15.38)
Associates	2 (4.65)	0	2 (2.20)
None	14 (32.56)	18 (37.50)	32 (35.16)
Intellectual Functioning			
WTAR FSIQ	Mean ± SD	Mean ± SD	Mean ± SD
	84.51 ± 6.90	83.15 ± 6.54	83.78 ± 6.71
Baseline Cognitive Functioning			
Working Memory			
Z score -0.5	33 (76.7)	38 (79.2)	71 (78)
Z score -1.0	23 (53.5)	28 (58.3)	51 (56)
Verbal Memory			
Z score -.5	30 (69.8)	36 (75)	66 (72.5)
Z score -1.0	18 (41.9)	27 (56.3)	45 (49.5)
Executive Functioning			

Variables		TCT (n = 43) n (%)	GCA (n = 48) n (%)	Total (n = 91)
Z score	-0.5	19 (44.2)	27 (56.3)	46 (50.5)
Z score	-1.0	12 (27.9)	14 (29.2)	26 (28.6)
Attention				
Z score	-0.5	19 (44.2)	16 (33.3)	35 (38.5)
Z score	-1.0	6 (14)	8 (19.7)	14 (15.4)
Processing Speed				
Z score	-0.5	25 (58.1)	32 (66.7)	57 (62.6)
Z score	-1.0	12 (27.9)	20 (41.7)	32 (35.2)
Global				
Z score	-0.5	25 (58.1)	31 (64.6)	56 (61.5)
Z score	-1.0	8 (18.6)	18 (37.5)	26 (28.6)

Table 2

Mean/SD Z scores at Baseline, and after 13 and 26 sessions

Group	Outcome	Baseline			Mid-point (13 weeks)			Post-treatment (26 weeks)				
		N	Mean	SD	N	Mean	SD	d (mid-base)	N	Mean	SD	d (post-base)
All (N=91)	WM	91	-0.83	0.66	30	-0.85	0.61	0.23	22	-0.70	0.71	0.06
	VM	91	-0.89	0.77	30	-0.41	0.74	0.88 ^{***,†}	22	-0.03	0.85	0.80 ^{***,†}
	EF	91	-0.56	0.76	30	-0.07	0.85	1.02 ^{***,†}	22	-0.12	0.62	0.47 [*]
	AT	90	-0.22	0.81	30	-0.03	0.85	0.31	22	-0.18	0.51	0.25
	PS	91	-0.52	0.74	30	-0.19	0.66	0.50 [*]	22	-0.48	0.76	0.02 ^{***}
	Global	91	-0.60	0.54	30	-0.31	0.57	1.54 ^{***,†}	22	-0.29	0.51	0.66
	BDI-II	91	11.59	9.49	30	10.77	9.35	-0.31	22	9.77	11.02	-0.06
	BAI	91	7.27	7.90	30	8.10	11.86	-0.18	22	4.86	7.25	-0.16
	GSI T	90	59.72	12.48	30	58.78	15.81	-0.31	22	53.20	15.70	-0.33
	PST T	91	55.89	11.57	30	56.63	13.98	-0.35	22	50.41	14.91	-0.31
PSDI T	91	62.39	11.78	30	59.47	13.01	-0.32	22	60.82	14.65	-0.01	
TCT (N=43)	WM	43	-0.77	0.68	12	-0.71	0.52	0.24	10	-0.60	0.72	0.00
	VM	43	-0.78	0.63	12	-0.27	0.67	0.47	10	-0.25	1.00	0.82 [*]
	EF	43	-0.48	0.78	12	0.12	0.90	1.23 ^{**}	10	-0.06	0.63	0.23
	AT	43	-0.21	0.86	12	-0.01	0.95	0.53	10	-0.10	0.58	0.34
	PS	43	-0.48	0.70	12	-0.20	0.55	1.16 ^{**}	10	-0.54	1.01	-0.12
	Global	43	-0.54	0.52	12	-0.21	0.56	2.11 ^{***,†}	10	-0.29	0.61	0.53
	BDI-II	43	10.49	8.80	12	11.83	11.18	0.05	10	10.50	11.51	0.06
	BAI	43	5.70	7.28	12	6.00	7.05	-0.04	10	4.60	7.71	0.05
	GSI T	43	58.24	12.80	12	60.42	15.88	0.06	10	53.00	15.89	-0.35
	PST T	43	53.84	11.84	12	55.50	14.33	-0.10	10	50.10	14.65	-0.24
PSDI T	43	61.44	12.67	12	60.25	14.40	-0.02	10	62.90	14.18	-0.07	
GCA (N=48)	WM	48	-0.88	0.65	18	-0.94	0.66	0.23	12	-0.79	0.72	0.10
	VM	48	-0.99	0.87	18	-0.50	0.79	1.33 ^{***,†}	12	0.15	0.69	0.91 ^{***}
	EF	48	-0.62	0.74	18	-0.20	0.81	0.90 ^{**}	12	-0.17	0.64	0.67 [*]
	AT	47	-0.24	0.77	18	-0.05	0.81	0.16	12	-0.24	0.46	0.16

Group	Outcome	Baseline			Mid-point (13 weeks)				Post-treatment (26 weeks)			
		N	Mean	SD	N	Mean	SD	d (mid-base)	N	Mean	SD	d (post-base)
	PS	48	-0.56	0.78	18	-0.19	0.74	0.25	12	-0.43	0.51	0.18
	Global	48	-0.66	0.55	18	-0.37	0.59	1.26 ^{***, †}	12	-0.30	0.43	0.77 [*]
	BDI-II	48	12.58	10.06	18	10.06	8.18	-0.53 [*]	12	9.17	11.08	-0.16
	BAI	48	8.69	8.24	18	9.50	14.23	-0.25	12	5.08	7.18	-0.39
	GSI T	47	61.06	12.16	18	57.69	16.13	-0.51	12	53.38	16.25	-0.30
	PST T	48	57.73	11.12	18	57.39	14.11	-0.48	12	50.67	15.76	-0.35
	PSDI T	48	63.24	10.98	18	58.94	12.41	-0.47	12	59.08	15.42	0.03

WM = Working Memory, VM = Verbal Memory, EF = Executive Functioning, AT = Attention, PS = Processing Speed

^{*} p<0.05;

^{**} p<0.01;

^{***} p<0.001;

[†] p<0.05 after Bonferroni correction (66 comparisons in total)

Table 3

Percentage of Improvers with RCI >1.96 after 13 sessions (N = 30)

Cognitive Area and Test		# of improvers	% RCI>1.96
VM	WMS-IV Logical Memory I	25	20
	WMS-IV Logical Memory II	21	0
	CVLT-II Free Recall	18	11
	CVLT-II Long Delay	14	0
EF	D-KEFS Trail Making Condition 4	19	5
	D-KEFS Verbal Fluency – Letter Fluency	18	11
	D-KEFS Tower Tests – Total Achievement	23	13
AT	D-KEFS Trail Making Condition 1	7	28
	D-KEFS Trail Making Condition 2	10	60
	D-KEFS Trail Making Condition 3	11	18
WM	Working Memory Index	16	6
PS	Processing Speed Index	20	10

VM = Verbal Memory, EF = Executive Functioning, AT = Attention, WM = Working Memory, PS = Processing Speed